Comparison of neuropsychological and brain imaging data in pediatric brain tumor patients surviving more than 10 years

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NP-001. INTRUSION INTO SELF-PERCEPTION BY CNS TUMOR AND TREATMENT IN CHILDHOOD OR ADOLESCENCE: POPULATION-BASED OUTCOMES FROM ADULT SURVIVORS EARLY CEREBELLAR INJURY AND GENERAL POPULATION

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BACKGROUND: Survivors of pediatric central nervous system (CNS) tumors face at risk persistently a majority of survivors report adverse psychological impact of the illness on disability and social consequences which may intrude into self-perception, vital for mental health and quality of life. Within the longitudinal Swedish CNS tumor LIFE-study, we studied the long-term impact of the childhood CNS tumor and its treatment on self-perception in significant domains in adult survivors, by comparison with those of the general population. METHODS: The cohort included 697 Swedish survivors diagnosed between 1982 and 2001 with a primary CNS tumor. Comparison data were collected from a stratified general population random sample. Survivors and general population individuals were matched for age, gender and persistent visible physical appearance sequelae predicted to be predicted from IQ scores on the WISC-IV. RESULTS: Cognitive processing was below average (100) in all of the children and significant impairments in academic achievement (WIAT-II) and cognitive functioning (WISC-IV). The analysis was performed in a mixed-effects regression model including measures similar to what was used in this study. CONCLUSIONS: These results suggest that early injury to the cerebellum has a generic effect on cognitive processing that underpins development of scholastic skills. Additional academic difficulties are likely to occur in children with invasive tumours requiring more aggressive treatment probably because chemotherapy and radiotherapy are known to affect attentional processing which is critical for scholastic progression.

NP-002. DO SCHOLASTIC DIFFICULTIES IN CHILDREN WITH EARLY CEREBELLAR INJURY ARISE FROM SPECIFIC OR GENERAL IMPAIRMENTS?

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OBJECTIVE: Poor scholastic performance has been reported following early cerebellar injury, but it is currently not known if these difficulties arise from a general cognitive impairment. Hence, it is difficult to target interventions effectively. Using a case-series approach, we investigated the extent of scholastic difficulties, above and beyond general cognitive processing that underpins development of scholastic skills. Additional academic difficulties are likely to occur in children with invasive tumours requiring more aggressive treatment probably because chemotherapy and radiotherapy are known to affect attentional processing which is critical for scholastic progression.

NP-003. CHILDREN WITH CEREBELLAR MEDULLOBASTOMA AND WORKING MEMORY DISORDERS: A FUNCTIONAL MRI STUDY

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BACKGROUND AND PURPOSE: Medulloblastomas are the most common malignant brain tumors in childhood. Children treated for a cerebellar medulloblastoma demonstrated cognitive disorders in working memory (WM), especially visuospatial WM, leading to an impairment of school performance. The purpose of this study is to describe the cerebellar involvement in specific cognitive deficits observed in children treated for cerebellar medulloblastoma.

MATERIALS AND METHODS: Groups: Nine healthy volunteers (11.1 ± 2.2 yo), were compared to 5 patients treated for cerebellar medulloblastoma (12.1 ± 0.6 yo). All subjects were native French speakers, right-handed, with a global IQ of 70-130. Using 4 block-design fMRI paradigm, 1-back tasks in the sensorial modality (visual/auditory) and the nature of information (verbal/nonverbal) during fMRI acquisitions (T2* weighted gradient-echo - EPI) and completing with an anatomic acquisitions (3D T1-weighted). Data Analysis: Using the Statistical Parametric Mapping (SPM8) and the Spatially Unbiased Infra-tentorial Template (SUIT) for viewing cerebellar topography with BOLD activations. RESULTS: In patients group: 4/5 patients had a WM deficit following a resection of the left posterior cerebellar lobe (lobule HVII, HVIII, HI, and posterior part CVII). The only patient without WM deficit was the only one without cerebellar hemispheric resection (figure 1), even though this patient was also treated with radiotherapy and chemotherapy dosages like those in other patients. Greater BOLD activations were found in the left posterior cerebellar lobe for nonverbal vs. verbal contrast and they were presented in this region for visual vs. auditory contrast (figure 2). In a healthy subject, greater BOLD activations were found in brain and cerebellar locations which are similar with those in the literature for all four tasks. CONCLUSION: The cerebellum plays the same role in WM in children as that has previously been described in adults. The left posterior cerebellar lobe may involve the visuospatial WM.

NP-004. THE EFFICACY OF COMPUTERIZED COGNITIVE REHABILITATION TRAINING IN THE CHILD TREATED FOR MEDULLOBLASTOMA

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OBJECTIVES: Neurocognitive deficits are common after brain tumor treatments. Our study suggests that computer-based means of rehabilitation lead to better cognitive functioning. Thus there is a need to include cognitive rehabilitation in a standard protocol. The present single case study evaluates the improvement of general cognitive functioning of a pediatric patient who underwent rehabilitation program targeting memory, attention and alertness. METHODS: The pediatric patient (age 7.5) diagnosed with medulloblastoma underwent surgery, craniospinal irradiation (23.4 Gy, with 2Gy boost to the tumor and 3Gy to the first 5 posterior cerebellar area) and inferior part of vermis; the only patient without WM deficit was the only one without cerebellar hemispheric resection (figure 1), even though this patient was also treated with radiotherapy and chemotherapy dosages like those in other patients. Greater BOLD activations were found in the left posterior cerebellar lobe for nonverbal vs. verbal contrast and they were presented in this region for visual vs. auditory contrast (figure 2). In a healthy subject, greater BOLD activations were found in brain and cerebellar locations which are similar with those in the literature for all four tasks. CONCLUSION: The cerebellum plays the same role in WM in children as that has previously been described in adults. The left posterior cerebellar lobe may involve the visuospatial WM.

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spatial working memory, visuospatial attention (at \( p < 0.001 \)) and selective attention (at \( p < 0.03 \)). Reliable change index (RC) confirmed improvements on neuropsychological tests. CONCLUSIONS: Computer-based cognitive rehabilitation interventions improves performance in children with cerebellar mutism syndrome. Clinical implications of WISC-R contains items of structural thinking, disordered in patients with brain damage; most tests are time limited, which reduces patients outcomes. CONCLUSIONS: Reliable assessment of neuropsychological functions in brain tumors requires a specific cognitive rehabilitation protocol. This new tool is designed for screening, diagnosis, prognosis of neuropsychological consequences, planning and evaluation of rehabilitation process. Proposal of this tool specific for brain tumor survivors and draft recommendations for diagnosis of specific neuropsychological consequences will be presented and discussed.

**Abstracts**

**NP-005. COMPARISON OF NEUROPSYCHOLOGICAL AND BRAIN IMAGING DATA IN PEDIATRIC BRAIN TUMOR PATIENTS SURVIVING MORE THAN 10 YEARS**

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AIM: To explore the relationship between neuropsychological outcome and magnetic resonance imaging (MRI) findings in paediatric brain tumour patients surviving more than 10 years. BACKGROUND: Cognitive late sequelae after paediatric brain tumour have a multifactorial origin. Low age at diagnosis, cranial radiation therapy, intrathecal methotrexate treatment and increased intracranial pressure are known to predict cognitive sequelae. Cognitive sequelae have been related to MRI findings, but the relation between neuroimaging findings and neuropsychological impairment needs to be explored further. METHOD: Sixteen paediatric brain tumour survivors completed an extensive neuropsychological test battery and MRI 10 to 13 years after diagnosis. Patients were first separately classified as positive or negative regarding neuropsychological impairment and MRI findings, and then coded as congruent or incongruent, depending on whether neuropsychological outcome was in agreement with MRI also considering clinical data such as type and location of the brain tumour, post-operative status, treatments or premorbidity. RESULTS: Ten patients were classified as either positive or negative for both MRI and cognitive impairment if blinded for the second parameter and clinical data, and were also congruent for these two parameters when not blinded for clinical data and the second parameter. In five out of six initially incongruent patients the neuropsychological profile was in accordance with MRI findings when evaluating all data with the multidisciplinary holistic approach. CONCLUSIONS: Cognitive outcome in survivors of paediatric brain tumours depends on many different detrimental processes and shows high individual variation. Congruity between neuropsychological impairment and MRI findings might at first seem low. However, in the perspective of a clinical holistic evaluation of MRI findings and neuropsychological outcome considering the knowledge of clinical data such as type and location of the brain tumour, type of MRI findings (atrophy, gliosis, post-operative lesion), undergone treatments and radiation field as well as premorbid cognitive impairment congruity increases.

**NP-006. NEW APPROACH TO ASSESSMENT OF NEUROPSYCHOLOGICAL LATE EFFECTS IN CHILDHOOD BRAIN TUMOUR SURVIVORS. CHALLENGES AND BENEFITS OF THE NEW METHODOLOGY**

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PURPOSE: The purpose of the study was to analyze the usefulness of standard psychological and neuropsychological assessment tools used in evaluating neuropsychological consequences of childhood brain tumors. The hypothesis was that in this specific group of patients standard tests are not sufficient to evaluate long term effects of childhood brain tumors. METHOD: The base of the study was psychological repeated testing performed in 350 childhood brain tumor survivors (various tumors types and localizations). Age at psychological diagnosis: 6 to 26 years. Full psychological outcome included assessment of problems with: memory, visual-motor skills, attention, flexibility, problem solving, semantic memory and fluency, motor skills, processing speed. The patients were examined by using standardized psychological and neuropsychological methods, mainly: Wechsler Intelligence Scales; Benton Visual Retention Test; L Bender + E. Kopitz Visual Motor Test; Rey – Osterrieth Complex Figure Test; Auditory Verbal Learning Test. Meta-analysis of results to verify the accuracy, relevance and reliability of the standard tests used to assess cognitive status of these patients was performed. RESULTS: Our results showed that neurocognitive functions (not just language) in the years following treatment. This lends support to the idea that the presence of CMS is an indication of a disruption in cortical pathways associated with higher-order cognitive development and functioning.

**NP-007. LONG-TERM NEUROCOGNITIVE FUNCTIONING IN A CASE SERIES OF MEDULLOBLASTOMA SURVIVORS: THE IMPACT OF CEREBELLAR MUTISM SYNDROME**

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OBJECTIVE: About 25% of pediatric patients with medulloblastoma develop Cerebellar Mutism Syndrome (CMS) post treatment and worse neuropsychological outcomes have been reported but not systematically studied beyond Global IQ. We aim to present a matched case series of children with medulloblastoma with and without CMS on a range of neuropsychological functions. We predict that CMS+ children will perform worse than CMS- children and will have a greater prevalence of clinical impairments. PARTICIPANTS AND METHODS: We present 5 matched pairs of medulloblastoma patients off-treatment for at least 1 year; half were CMS+, PAIR participants were matched by diagnosis age, age at assessment, and treatment. All participants underwent a full neuropsychological evaluation. Descriptive data was calculated, and variables were dichotomized for clinical significance at one standard deviation below the mean. RESULTS: Age range was 9-18 yrs at time of evaluation (M = 14.6; SD = 2.41), with 50% males. Time off treatment for the CMS+ participants ranged from 1-13 yrs (M = 7.0; SD = 4.18), and 1-8 yrs (M = 4.0; SD = 2.34) in the CMS- group. 90% received radiation. CMS+ participants consistently showed scores below CMS- on Performance IQ, particularly Matrix Reasoning. PIQ was impaired in 80% of the CMS+ group and never in the CMS- group. Verbal IQ was impaired in 40% of the CMS+ group, and none of the CMS-. Similar patterns emerged for working memory, flexibility, memory, processing speed, and visual-motor integration. CONCLUSION: Based on this matched sample of medulloblastoma survivors, results suggest that CMS is associated with greater impairments across a range of neurocognitive functions (not just language) in the years following treatment. This lends support to the idea that the presence of CMS is an indication of a disruption in cortical pathways associated with higher-order cognitive development and functioning.

**NP-008. EPISODIC MEMORY IMPAIRMENTS IN PEDIATRIC TEMPORAL BRAIN TUMORS**

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BACKGROUND: Memory impairment has been reported in paediatric brain tumors using global neuropsychological assessments, but no study focused on long-term memory consolidation processes have been conducted in these childhood brain tumor patients. Therefore, we tested a long-term memory retrieval paradigm in children treated for temporal brain tumors. METHODS: We included 10 patients (6 to 18 yrs) treated for a malignant (N = 6) or benign (N = 4) temporal brain tumor in the Paediatric Department of Gustave Roussy Institute (France) and 12 matched controls (6 to 18 yrs.). The protocol involved two parts: 1) 9 recent daily memories were first collected, 2) after a delay of 16 days, a free recall (FR) of memories was requested. When memories were not retrieved in FR, a semantic cues recall (SCR) was performed. We first analyzed the accuracy of memories retrieved (QM) in part 2 and then, the qualities of memories using the episodic
score (ES) as a measure of the recall of rich contextual details. RESULTS: For FR, QM and ES were significantly lower in patients than in controls (QM: p < 0.001; ES: p < 0.001). For CR, QM did not differ significantly between patients and controls (p = 0.87), while ES was lower in the patients (p = 0.001). DISCUSSION: Patients showed episodic memory impairments characterized by a lower amount of memories retrieved and poorer details. However, patients were sensitive to semantic cues recall. Episodic memory impairment may be more associated with retrieval strategies than with consolidation impairments. Thus, investigating daily memories is relevant to capture memory deficits and their impact on quality of life of children treated for brain tumors. These findings also suggest new potential rehabilitation perspectives.

NP-009. PREOPERATIVE NEUROPSYCHOLOGICAL AND BEHAVIORAL EVALUATION OF CHILDREN WITH THALAMIC TUMORS

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INTRODUCTION: Functional involvement of the thalamus in cognitive processing has been only anecdotally reported in the literature and mostly related to thalamic haemorrhages; there is no available information on cognitive development in children with thalamic tumors. CLINICAL MATERIALS AND METHODS: All the children admitted with a diagnosis of thalamic tumor at our Institution between January 2008 and January 2011 were considered for the present study. Exclusion criteria were: age under 18 months and the presence of severe neurological deficits, both preventing a reliable neuropsychological evaluation. A complete preoperative neuropsychological evaluation was performed. RESULTS: Twenty children were selected (mean age 102.4 months). Total IQ was in the normal range in all patients (mean: 90.1; SD: 13.87) with a significant difference between VIQ (mean 97,70 SD 17,77) and PIQ (84,82 SD 17,01). A significant correlation was found between global IQ and an histological finding of low grade tumors (p = 0.001). Children with mesial thalamic tumor had higher working memory deficit and delayed recall disorders (p = 0.001). Naming disorders were related to the presence of a bilateral (p = 0.0001) stenotic thalamic tumor (p = 0.002) without a significant difference between the involvement of the left or right hemisphere. A significant correlation was also found between the presence of neurologic disorders and mesially located tumors (p = 0.001). Children with right sided tumors had more frequently constructional praxia and executive function disorders (p = 0.0005). CONCLUSION: The present study suggests that differently located thalamic tumors might have specific neuropsychological profiles.

NP-010. NEUROCOGNITIVE DEFICITS IN CHILDREN WITH BRAIN TUMOR PATIENT DIAGNOSIS

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Survivors of brain tumors are faced with a high risk for a wide range of cognitive problems and learning difficulties. These problems are caused by the lesion itself and its surgical removal as well as by the treatments to follow (chemo- and/or radiation therapy). A few recent studies have indicated that children with brain tumors (BT) might exhibit cognitive problems already at diagnosis, i.e., before the start of any medical treatment. The aim of the present study was to investigate the “baseline” neuropsychological profile in children with BT in comparison to children with an oncological diagnosis not involving the central nervous system (CNS). 20 children with BT and 27 children with an oncological disease without involvement of the CNS (age range: 8.1 to 16.9 years) were evaluated with an extensive battery of neuropsychological tests tailored to the patient’s age. Furthermore, the child and its parents completed self-report questionnaires about emotional functioning and quality of life. In both groups, tests were administered in the areas of perception, reasoning, processing speed, and memory. RESULTS: Statistical analysis of our study revealed executive functions disturbances in both groups. Differences in performances on executive function measures were found, in both classical and ecological tests in our population. Significant and strong correlations were found between IQ measures and EF measures. Medical factors were identified on performances based in our population, such as epilepsy in our population, for medical factors, and socioeconomic status for social factors.

NP-011. ASSESSMENT OF EXECUTIVE FUNCTIONING IN CHILDREN AND YOUNG ADULTS TREATED FOR FRONTAL Lobe Tumours USING ECOLOGICALLY VALID TESTS

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The first aim of the study was to evaluate executive functions in children and adolescents treated for benign and malignant frontal lobe tumours. To measure and to evaluate executive functioning in our population, both ecological valid tests and a classical evaluation of executive functions was performed. For ecological neuropsychological tests, the BADS-C (Behavioral Assessment of the Dysexecutive Syndrome for Children) an ecological battery and the BRIEF questionnaire were performed for parents and teachers of children and adolescents of our comparison group. Classical tests of executive functions such as the Wisconsin Card Sorting test and the Tower of London. To our knowledge, no study to date has directly measured ecological measures and classical tests measures in same population. The second aim of the study was to assess correlations between the classical tests and ecological tests, such as the BADS-C and the BRIEF questionnaire in our population. The third aim of the study was to identify and to determine the specific factors (medical factors, social factors) influencing performance in our population. METHOD: Between September 2010 and June 2012, 21 patients treated for frontal benign/malignant lobe tumour were included aged 8-21 years at time of evaluation. Age at surgery was 8.3 years old. A comparison group of 42 patients were matched on gender, age and level education, on classical tests and on the BADS-C battery. RESULTS: Statistical analysis of our study revealed executive functions disturbances in children and adolescents. Working memory disabilities, planning organization difficulties were found, in both classical and ecological tests in our population. Significant and strong correlations were found between IQ measures and EF measures. Medical factors were identified on performances based in our population, such as epilepsy in our population, for medical factors, and socioeconomic status for social factors.

NP-012. IQ CHANGE OVER TIME IN PEDIATRIC BRAIN Tumor PATIENTS TREATED WITH PROTON BEAM RADIATION THERAPY VERSUS PHOTON RADIATION THERAPY

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BACKGROUND: Cranial radiation therapy (RT) is associated with neurocognitive toxicity. Compared to photon radiation (XRT), proton therapy (PT) reduces the volume of normal tissue receiving radiation dose, which may lead to better neurocognitive outcomes. We examined change in IQ over time between patients treated with PT versus XRT. METHODS: We abstracted IQ scores of pediatric brain tumor patients treated with PT or XRT. A general linear mixed model examined change in IQ over time by RT type (PT vs. XRT), controlling for age-at-RT, total-RT-dose, craniospinal irradiation (CSI), shunt, and tumor location. RESULTS: IQ declined significantly in both groups (p < 0.05); however, the rate of IQ decline did not differ significantly between groups (XRT = 1.4 points/year, PT = 1.1 points/year, p = 0.60); however, the rate of IQ decline did not differ significantly between groups (XRT = 1.4 points/year, PT = 1.1 points/year, p = 0.60). IQ was also significantly lower among patients with shunts (p < 0.01); CSI nearly reached significance (p = 0.057), while age-at-RT (p = 0.495), total-RT-dose (p = 0.583), and tumor location (p = 0.601) were not significantly associated with IQ, after controlling for all other variables in the model.
NP-013. NEUROCOGNITIVE SCREENING TOOL FOR PEDIATRIC BRAIN TUMOR: RELIABILITY AND VALIDITY
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PURPOSE: Research on pediatric brain tumor (PBT) patients has identified long-term neurocognitive deficits in attention, memory, and executive functioning. There is a need for brief neuropsychological screening measures that can readily detect impairment and be administered to guide early intervention. This study examined the reliability and validity of the Lebby-Ashbel Neurocognitive Screening Examination (LANSE) for PBT patients in a clinical setting. METHODS: Participants were 53 PBT (M age = 10.90, SD = 3.26; 52.8% White; Med months from diagnosis = 93.00, SD = 46.25) and 30 comparison traumatic brain injury (TBI) patients (M age = 11.89, SD = 4.08; 50% Caucasian; Med months from injury = 133.00, SD = 61.19). The LANSE is a brief (20-25 minutes) measure of patient orientation, attention, executive functioning, language, verbal and visual memory, and visual-spatial functioning normed on children with TBI. BT and TBI patients between the ages of 6 to 17 years were administered the LANSE by trained psychology staff. A subset of children with PBT and TBI (ns = 6 to 18) also completed the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV, CVLT-C, and WMS-IV) or WISC III and WMS III from the LANSE are consistent with full neurocognitive examination and CMS (r's range from 0.55 to 0.93). CONCLUSION: Screening results hypothesized direction with similar domains on the WISC-IV, CVLT-C, and/or Children's Memory Scale (CMS). RESULTS: PBT patients exhibited a similar degree of impairment as TBI patients on the LANSE. Specifically, PBT patients exhibited similar impairments as TBI patients across the domains of attention, language, executive functioning, as well as visual and verbal memory. These domains showed good reliability (α's ranged from 0.67 to 0.88) and correlated significantly in the hypothesized direction with similar domains on the WISC-IV, CVLT-C, and WMS-IV. CONCLUSION: Screening results from the LANSE are consistent with full neuropsychological examination results reported in the literature. The LANSE is a reliable and valid screening measure easily administered in clinic that may be a valuable tool for detecting neurocognitive impairment during and after treatment.

CONCLUSIONS: Findings suggest both PT and XRT are associated with cognitive risk. While the rate of IQ decline did not differ significantly between RT types in this sample, IQ scores in the XRT group started and remained lower compared to the PT group. The different cognitive outcomes, particularly for non-CSI PT patients, are needed.

NP-014. NEUROPSYCHOLOGICAL FOLLOW-UP OF HEAD START II SURVIVORS: AN UPDATE
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PURPOSE: Given the neuropsychological deficits associated with irradiation in young children diagnosed with malignant CNS tumors, the Head Start II protocol employed high-dose myeloablative chemotherapy followed by autologous hematopoietic cell transplantation to avoid or delay craniospinal irradiation. This research examined long-term neuropsychological functioning of patients treated on the Head Start II protocol between 1997 and 2003. METHODS: Patients completed baseline testing prior to autologous transplantation and biannually thereafter. Assessments were completed for 49/51 (96%) patients at baseline (T1 mean age = 3.4 years; SD = 2.2); Twenty patients passed away between T1 and T2. 27/31 (87%) completed assessments at T2; 16/31 (52%) at T3; 6/31 (19%) at T4, and one at T5. Analyses compare neuropsychological functioning at baseline to most recent follow-up assessment (T2 to T5; mean length of follow-up = 7.39 years, SD = 3.21) and examine outcomes for patients who received intravenous methotrexate (IVMTX) compared to those who did not. RESULTS: Dependent samples t-tests comparing performance at baseline and most recent follow-up revealed no significant change over time on FSIQ, PIQ, VIQ, reading, spelling, math, general memory, verbal or visual delayed memory. For the entire group, Full Scale IQ (FSIQ, VIQ, PIQ) resulted in a mean decrease of 0.43 points. Although not significant, PIQ scores declined 3.25 points and VIQ scores increased 3.25 points from baseline. Mean scores at most recent follow-up indicate that survivors performed within the average to low average ranges (all p < 0.001), with low average ranges for most recent treatment group means did not reveal any significant differences, with the exception of lowered visual delayed memory for those who received IVMTX (p = 0.03). CONCLUSIONS: These analyses include neuropsychological outcome data for children up to 12-years post-diagnosis of a malignant CNS tumor, indicating that children treated with a protocol aimed to reduce late effects on neurocognitive development continue to display broadly stable neuropsychological functioning over extended follow-up.

NP-015. WHITE MATTER DAMAGE DISRUPTS NEURAL PHASE SYNCHRONY AND IMPAIRS COGNITIVE PERFORMANCE IN CHILDREN TREATED WITH CRANIAL RADIATION FOR BRAIN TUMOURS OF THE POSTERIOR FOSSA
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Cognitive impairments are consistently reported in children treated with cranial radiation (CRT) for brain tumours. These deficits are, at least in part, neural attributable to white matter damage. We investigated how white matter damage and poor task performance related to neural function by comparing functional measures obtained with Magnetoencephalography and structural measures obtained with Diffusion Tensor Imaging to visual-motor task performance in eighteen healthy children (12M/6F: 11.3 yrs +/- 3.5) and 20 pediatric Posterior Fossa (PF) brain tumour patients (13M/7F: 12.07 yrs +/- 2.58) who had been treated with CRT (15 medulloblastoma, 3 ependymoma, all received CRT treatment of either focal (PF only) with PF boost, or whole-brain with PF boost). White matter health and injury measures predicted reaction times in both groups. White matter structure predicted faster reaction times on task performance in both healthy children (r = -.72, p < .001) and patients (r = -.52, p < .05). Functionally, phase synchrony of the visual cortex in response to the visual cue was the best predictor of performance. Phase synchrony is the temporal consistency of the neural response from trial to trial and reflects the coordination of neural communication across brain regions. In downstream target areas, phase synchrony was correlated with increased white matter health (r = .64, p < .01) and faster reaction times (r = -.51, p < .05). In patients, decreased phase synchrony was correlated with decreased white matter health (r = .53, p < .05) with no relationship to reaction time. We propose that the condition of white matter influences reaction time on a visual-motor task through the temporal coordination of information arriving at the visual cortex. The phase synchrony of the neural response may be a biomarker of white matter injury and cognitive impairment in children treated for brain tumours.

NP-016. LONG-TERM OUTCOME IN SUBGROUPS OF MEDULLOBLASTOMA
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BACKGROUND: Treatment for medulloblastoma is associated with white matter damage and cognitive morbidity. Reducing treatment in subgroups of medulloblastoma with better prognosis could spare certain group(s) from neuro-toxic complications. We examined relations between subgroup (WNT, SHH, Group 3, Group 4) and late effects to identify differences in long-term outcome. METHODS AND RESULTS: (i) Quality-of-life data (Health Utilities Index) were collected from 67 patients (6 WNT, 18 SHH, 11 Group 3, 27 Group 4, 4 unclassified) across 8 sites in the Medulloblastoma Advanced Genomic International Consortium. Of 13 attributes assessed, only cognition differed between subgroups; the mean single-attribute utility score was higher for SHH (0.98 ± 0.03) than Groups 3 (0.95 ± 0.04; p = 0.007) and 4 (0.96 ± 0.03; p < 0.029). We further investigated cognitive outcome by comparing rate of change in intellectual functioning of 91 patients (41 Group 4; 20 Group 3; 18 SHH; 12 WNT) treated at SickKids. WNT was excluded from the following analyses due to its relatively small sample size. Groups 3 and 4 declined by ±4.9 IQ points/year (all p < 0.001, all low average ranges). Whereas SHH declined by 2.2 IQ points/year (p = 0.18). A subset of these patients (14 Group 4; 6 Group 3; 8 SHH) and 38 controls underwent diffusion tensor imaging to assess (iii) white matter microstructure and identify potential structural correlates of cognitive morbidity. Relative to controls, Group 4 had reduced WM MD in temporal (mean differences: FA +0.03 ± 0.009; RD = 0.000041 +
OBJECTIVES: The hippocampus is critical for learning and memory. Children treated for medulloblastoma exhibit lower memory performance and smaller hippocampal volumes as compared to healthy controls (Riggs et al., 2013) and the TXT group exhibited significantly more change in average hippocampal volume. The TXT group also exhibited more change in average hippocampal volumes compared to the CTRL group (p = 0.001). A linear regression model was used to examine changes in hippocampal volume over time. This model revealed a significant difference in hippocampal volume in the MB group compared to the CTRL group (p = 0.0001). In the MB group, there was an estimated 2.89% decrease in hippocampal volume each year (baseline = 3568.14 mm³, 3 year follow-up = 3275.04 mm³). CONCLUSIONS: The current results suggest that aerobic exercise may be an effective intervention in repairing some of the damage following radiation. Future work will examine the impact of clinical factors such as radiation dose and the occurrence of hydrocephalus on hippocampal volume and its developmental trajectory.

NP-018. EXERCISE INCREASES HIPPOCAMPAL VOLUME IN CHILDREN TREATED WITH CRANIAL RADIATION
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OBJECTIVES: Cranial radiation has been linked to smaller hippocampal volumes, which may alter the observed memory impairments in children treated for brain tumours. There is evidence from the animal and adult literature suggesting that aerobic exercise can increase hippocampal volume, and improve memory performance. In this study, we conducted a waitlist control cross-over design study to examine the effects of exercise on hippocampal volume in children treated with cranial radiation. METHODS: 9 participants (age = 10.88 ± 2.53) were assigned to the treatment group (TXT), and 9 participants (age = 12.22 ± 3.37) were assigned to the waitlist control group (CTRL). The TXT group participated in group aerobic activities 3 times per week for 3 months. Participants were evaluated at baseline (T1) and post-intervention (T2). Then, the TXT group underwent a follow-up assessment 3 months after intervention (T3). The CTRL group underwent a third assessment (T3) after receiving the exercise intervention. Participants were scanned using a GE 1.5T or Siemens 3T MRI. Hippocampal regions were traced blind to group status and corrected for intra-cranial volume, scanner type and age. RESULTS: A repeated measures ANOVA revealed a significant difference by time interaction (F(1,14) = 25.43, p = .0001). At T2, the TXT group exhibited significantly more change in average hippocampal volume (0.09 ± 0.01 mm³) as compared to the CTRL group (p = 0.001). At T3, the TXT group exhibited significantly more change in average hippocampal volume (0.10 ± 0.01 mm³) as compared to the CTRL group (p = 0.001). At T3, the TXT group exhibited significantly more change in average hippocampal volume (0.10 ± 0.01 mm³) as compared to the CTRL group (p = 0.001). At T3, the TXT group exhibited significantly more change in average hippocampal volume (0.10 ± 0.01 mm³) as compared to the CTRL group (p = 0.001). At T3, the TXT group exhibited significantly more change in average hippocampal volume (0.10 ± 0.01 mm³) as compared to the CTRL group (p = 0.001).
suggest that emotional, behavioral or social impairments at diagnosis tend to stably persist throughout treatment and must then be target of early intervention. Moreover, specific neuropsychological rehabilitation might be beneficial in case of lesions involving the fourth ventricle. A larger cohort of patients and longer follow-up are required to better characterize our results.

NP-021. SOCIAL COGNITIVE DEFICITS AND REDUCED SOCIAL ATTAINMENT IN ADULT SURVIVORS OF CHILDHOOD CENTRAL NERVOUS SYSTEM (CNS) TUMORS

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BACKGROUND: Pediatric CNS tumor survivors are at risk for neurocognitive impairment, yet little is known about social cognition in adult survivors. METHODS: Participants included 78 adult survivors of childhood CNS tumors (53% infratentorial, 45% supratentorial) enrolled in the St. Jude Lifetime Cohort (mean SD current age = 28.1 years [5.8], age at diagnosis = 9.4 years [4.7], and time since diagnosis = 18.8 years [6.0]). Age-adjusted standard scores were calculated for measures of intelligence and social cognition including affect recognition (i.e. facial expression of emotion) and prosody (i.e. emotional tone of voice). Impairment was defined as performance >1 SD below the normative mean. Multivariable general linear models were used to examine associations between tumor location and treatment and social cognition. Logistic regression models examined associations between social cognition (i.e., prosody, facial recognition) and social outcomes. RESULTS: 30% of CNS tumor survivors were impaired on measures of facial affect labeling (p = 0.001), 32% for identifying prosody (p < 0.001), and 34% for matching prosody with nonverbal social cues (i.e. body posture, affect; p < 0.001). Infratentorial tumor survivors treated with craniospinal radiotherapy (CSI) performed significantly worse than infratentorial tumor survivors treated with focal RT, supratentorial survivors treated with focal RT, and survivors treated with no RT on measures of facial affect naming (p = 0.017) prosody identification (p < 0.002) and matching prosody with social cues (p = 0.007). These differences persisted after accounting for IQ. In models adjusted for IQ, sex and age, better performance on social cognition tasks increased the likelihood of full time employment by 55% (OR = 1.5, 95% CI 1.2-2.1) and independent living by 20% (OR = 1.2, 95% CI, 1.1-1.4). CONCLUSIONS: Adult survivors of pediatric CNS tumors demonstrated considerable impairment on measures of social cognition, with greater impairment observed for survivors of infratentorial tumors treated with CSI. Observed social impairment confers risk for reduced occupational attainment in adulthood and may have implications for the social independence and achievement of survivors.

NP-022. COMPUTERIZED ASSESSMENT OF NEUROCognitive FUNCTION IN PRESCHOOL- AND SCHOOL-AGED CHILDREN WITH BRAIN TUMORS

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OBJECTIVE: Psychometrically-valid and reliable neurocognitive assessment tools for young children are lacking, particularly for domains affected by brain tumors and their treatment. We examined the utility and construct validity of a brief, computerized assessment in a sample of preschoolers (aged 3-5) and school-aged children (aged 5-16) diagnosed with brain tumors (BT).

METHODS: Five computerized tasks using touch-screen technology were developed using the CogState assessment platform. Two versions of the tasks were used: one tailored for children 4-6 and one developed for older children and adolescents. Tasks included measures of processing speed, visual attention, working memory, visual learning, and executive functioning. Children completed these tests as well as traditional measures of intelligence, memory, visual-motor, and executive functioning. RESULTS: To date, 37 children with BT (M age = 10.4; 60% male, 84% White) have completed computerized testing. Participants ranged from 0-14 years since diagnosis (M = 4.5 years), 50% had received cranial radiation therapy. Mean intellectual functioning and parent-rated working memory were in the average range (FSIQ = 99.4, SD = 18.93; BRIEF Working Memory T = 57.9, SD = 12.99; CBCL/BASC Attention T = 52.4, SD = 8.30). Data supported the convergent validity of many computerized tasks for both the preschoolers and school-aged groups. For example, worse performance on a computerized version of the Wisconsin Card Sort Task was associated with executive dysfunction (r = 0.41, p < 0.05), longer time since diagnosis (r = 0.35, p < 0.05), and younger age at diagnosis (r = -0.43, p < 0.05). CONCLUSIONS: Computerized cognitive testing has potential advantages over traditional paper-and-pencil measures for children with BT at risk for neurocognitive sequelae, including brevity, multiple alternate forms, and reduced motor demands. If reliable and valid, these tasks could serve as rapid, low-cost cognitive monitoring tools that can be administered within an on-site neuropsychologist.

NP-023. NEUROINFO FOR KIDS -- DEVELOPMENT OF A MANUAL TO HELP CHILDREN WITH A BRAIN TUMOR TO MAKE THE BEST OUT OF THEIR NEUROPSYCHOLOGICAL TEST RESULTS

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As survival rates in pediatric neuro-oncology have risen over the past decades, tumor- and treatment related neurocognitive late effects remain problematic for survivors. Various guidelines emphasize the importance of neuropsychological evaluation at different time points and give recommendations concerning the way assessment is carried out. However, the test situation itself as well as the report of the test results can be very challenging for the survivors, possibly facing their own deficits and therefore feeling degraded. For this reason we developed a standardized, resource-oriented manual facilitating the reporting of test results, Neuroinfo for Kids (NIK). NIK is based on the concept of salutogenesis and focuses on empowering the child, helping the child to get realistic knowledge of his own strengths and weaknesses and to get ideas of how to best deal with potential deficits. PARTICIPANTS: 23 patients with different types of brain tumors at the Department of Pediatrics, Medical University of Vienna; 12 girls, 11 boys; mean age 10.9 [7-13 years]; mean age at onset 5.6; mean time since onset 5.39; treatment with surgery, chemotherapy and/or radiotherapy. METHODS: The first draft of NIK was evaluated in a pilot study, with respect to the study questions whether NIK has an influence on comprehension, manageability and the feeling of meaningfulness.

The young patients had to fill out standardized questionnaires before and after the intervention with NIK, which was carried out by a trained neuropsychologist. SPSS was used for statistical analysis. RESULTS: We found that NIK significantly increased knowledge about personal strengths and weaknesses. Moreover knowledge about possible interventions was significantly improved. However, general knowledge about neuropsychological assessment could not be increased. Besides, NIK had no impact on self-esteem of the participants. As a result of the pilot study the improved version NIK was defined.

NP-024. COGNITIVE OUTCOMES IN MEDULLOBLASTOMA PATIENTS WITH CEREBELLAR MUTISM AND SHUNTED HYDROCEPHALUS

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PURPOSE: Medulloblastoma survivors have lower cognitive scores than healthy peers, attributed to radiation therapy. We sought to assess the impact of cerebellar mutism and shunted hydrocephalus. METHODS: A retrospective chart review was completed of all 95 medulloblastoma patients treated at our institution between 1/2001 and 12/2013. Patients were excluded for age older than 21 years (4), incomplete data (8), no surgical resection (2), and rapid death (1). 80 charts were reviewed for age at diagnosis, sex, treatment, diagnosis of cerebellar mutism, presence of cerebral spinal fluid (CSF) shunt, and results and timing of cognitive testing. RESULTS: 38/80 had documented post-treatment neuropsychological evaluations, 26 males and 12 females, with a mean age of 8.2 years at diagnosis. 37/38 received radiation. 10 had cerebellar mutism, 8 a CSF shunt, and 4 had both. All (M age = 10.4; 60% male, 84% White) had IQ above average in all. CONCLUSIONS: A larger cohort of patients received the age appropriate Wechsler exam providing measures of full scale IQ (FSIQ), Verbal Comprehension, Perceptual Reasoning, Memory, and Processing Speed. The mean FSIQ in patients without cerebellar mutism or a shunt was 92.1, as compared to the normative mean of 100. In those with a CSF shunt it was 87, and 71.7 in those with cerebellar mutism. Performance was weakest in patients with cerebellar mutism and a CSF shunt, 67. Verbal scores were better than Perceptual and Working Memory measures in all groups. Processing speed was low in all. CONCLUSIONS: After treatment with radiation, children with medulloblastoma, patients demonstrate lower than average cognitive scores. Cerebellar mutism worsens the outcome further, particularly in patients requiring a shunt.