tire vertebral body(VB) was part of target volume in all patients. The IMPT plan was generated using 3 fields with single field optimisation technique. Last 5 patients were treated using dose gradient(DG) (98-93%) deliberately created in anterior most 3-5mm of VB. Initial 2 patients were treated with intention of covering entire VB with 98% isodose. Monte Carlo algorithm was used for dose calculations and optimisation, and robustness assessed for 3mm setup and 3.5% range uncertainty. RESULTS: The CSI dose ranged from 21.6GyE to 35GyE. In patients without DG, maximum and mean dose to esophagus(36.67GyE vs. 25.45GyE, 31.53GyE vs. 20.41GyE), midline mucosa(28.95GyE vs. 25.31GyE, 21.8GyE vs. 14.61GyE) and bowel bag(32.9GyE vs. 24.27GyE, 3.59GyE vs. 3.21GyE) were higher compared to patients with DG. Both patients where DG was not created, developed grade 2 esophageal toxicities requiring supportive care and treatment interruptions(4 and 2days). All 5 patients with DG did not develop significant esophageal toxicity and had no interruptions. CONCLUSION: Creating a dose gradient over anterior VB using IMPT reduces dose to esophagus and midline mucosa leading to lower acute esophageal toxicity which potentially avoids treatment interruptions during CSI.

RONC-24. PROTON THERAPY FOR PEDIATRIC EPENDYMOMA: MATURE OUTCOMES FROM THE UNIVERSITY OF FLORIDA AND MASSACHUSETTS GENERAL HOSPITAL

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OBJECTIVE: Report long-term efficacy and toxicity of proton therapy for pediatric ependymoma. MATERIALS AND METHODS: Between 2000–2017, 318 children with nonmetastatic grade II/III intracranial ependymoma received proton therapy at Massachusetts General Hospital and the University of Florida. Median age was 3.5 years (range, 0.7–21.3 years); 56% were male. Most (69%) tumors were in the posterior fossa and classified as WHO grade III (64%). Eighty-four percent had a gross total or near total tumor resection before radiotherapy and 30% received chemotherapy. Median radiation dose was 55.8 CGE (range, 50.4–59.4 CGE). RESULTS: Median follow-up was 6 years (range, 0.6–19.2 years). Seven-year local control, progression-free survival, and overall survival rates were 77.1% (95% CI 71.7–81.7%), 64.4% (95% CI 58.6–69.8%), and 82% (76.9–86.2%), respectively. Subtotal resection was associated with inferior local control (60% vs 80%; p<0.01), progression-free survival (49% vs 67%; p<0.01), and overall survival (69% vs 84%; p<0.05). Male gender was associated with inferior progression-free (59% vs 71%; p<0.01) and overall survival (77% vs 89%; p<0.05). Twenty patients (6.2%) require hearing aids; of these, 12/20 received cisplatin. Grade 3+ brainstem toxicity rate was 1.6% and more common in patients who received >54 CGE. The rate of second malignancy was 0.9%. CONCLUSION: Proton therapy offers commensurate disease control to modern photon therapy without unexpected toxicity. The high rate of long-term survival justifies efforts to reduce radiation exposure in this young population with brain tumors. Independent of modality, this large series confirms extent of resection as the most important modifiable factor for survival.

RONC-25. A CASE OF PEDIATRIC PONTINE GLIOMA TREATED WITH GAMMA KNIFE SURGERY

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BACKGROUND: Pediatric brainstem gliomas rarely occur and are a heterogeneous group of diseases, which increases the difficulty of treatment strategy. Here, we present a case of pediatric pontine glioma treated with Gamma Knife surgery (GKS) after open biopsy. CASE DESCRIPTION: An 11-year-old boy presented with diplopia due to the left MLF syndrome. MRI showed a well-circumscribed, protruding tumor with partial gadolinium enhancement in the dorsal pons. An open biopsy was performed via the suprafacial triangle following midline suboccipital approach. Histological examinations revealed high cellularity and mild atypia. Immunohistochemistry demonstrated positive stain for GFAP and Olig2 antibodies, and negative for p53 protein. The Ki67-labeling index was 6.8%. Pyrosequence analysis indicated IDH1/2 wild type (wt), BRAF V600 wt, H3F3A K27 wt, FGFR1 wt, and TERT wt. The final diagnosis was pediatric diffuse astrocytoma, WHO grade II, pons. GKS was performed one month after the biopsy. After transient worsening of the symptom, it disappeared gradually. The tumor is stable for three years with mild shrinkage of the size. DISCUSSION: Gross total resection (GTR) of pediatric low-grade, brainstem gliomas may result in a good prognosis. However, unlike pilocytic astrocytoma, diffuse astrocytoma is not easy to perform GTR without any complications. There are some reports regarding GKS for brainstem gliomas, which prove an increase in progression free survival rate. No marked tumor regression is achieved in our case, but tumor growth is well-controlled so far. CONCLUSION: GKS after biopsy can be a useful treatment option for pediatric low-grade brainstem gliomas.

RONC-26. A CASE OF RADIATION NECROSIS OF THE CEREBELLUM 16 YEARS AFTER CHEMORADIOTHERAPY FOR MEDULLOBLASTOMA

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BACKGROUND: If new lesions are observed during follow-up of the malignant tumor after treatment, it is difficult to distinguish whether the tumor is a recurrent lesion, secondary cancer, or radiation necrosis of the brain. We have encountered a patient with symptomatic radiation necrosis of the cerebellum 16 years after treatment of medulloblastoma. CASE PRESENTATION: A 24-year-old man who had received a tumor resection and chemoradiotherapy for cerebellar medulloblastoma at the age of 8 presented with dizziness. For the past 16 years, there was no recurrence of the tumor. He subsequently underwent MRI scan, and T1-Gd image showed enhanced lesion in the right cerebellar peduncle. Cerebrospinal fluid cytology analysis was negative for tumor. We suspected tumor reccurence or secondary cancer, and performed lesion biopsy. The result of the pathological examination was radiation necrosis of the cerebellum. DISCUSSION: The interval of radiation necrosis of the brain and radiotherapy can vary from months to more than 10 years. So, whenever a new lesion is identified, radiation brain necrosis must be envisioned. According to guidelines in Japan, there is no absolute examination for discriminating tumor recurrence from radiation brain necrosis and diagnosis by biopsy may be required. CONCLUSION: We experienced a case of symptomatic radiation necrosis of the cerebellum 16 years after treatment. In patients showing new lesion after long periods of time, the possibility of radiation necrosis to be considered.

RONC-27. PROTON THERAPY REDUCES DOSE TO CRITICAL CENTRAL NERVOUS SYSTEM STRUCTURES IN MEDULLOBLASTOMA: A DOSIMETRIC ANALYSIS OF CHILDREN'S ONCOLOGY GROUP (COG) ACNS0331

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BACKGROUND: Recently published data demonstrated proton therapy (PRT) significantly reduced cognitive decline relative to photons for pediatric medulloblastoma. These findings imply that reductions in dose to critical CNS structures during the boost phase may account for better outcomes over time. Here, we examine differences in dosimetric data for medulloblastoma patients treated on ACNS0331 with photon (Intensity Modulated Radiation Therapy, 3D-Conformal Radiation Therapy) vs PRT to identify potential structures responsible for cognitive benefit. METHODS: COG ACNS0331 was a randomized trial examining the impact of reduced craniospinal irradiation (CSI) dose (standard vs low dose, in patients aged 3–7) and volume (whole posterior fossa vs involved field) in pediatric medulloblastoma patients. We identified 136 patients (IMRT=95, 3DCRT=28, Proton=13) enrolled on ACNS0331 with complete radiation and imaging data and re-contoured 10 critical brain structures to calculate dose. RESULTS: Proton therapy significantly reduced the dose to critical structures. For example, temporal lobe mean dose and V30 were 30Gy/38% (PRT), 40Gy/89% (IMRT), 41Gy/84% (3DCRT)), hippocampi mean dose were 51 Gy (IMRT), 52 Gy (3DCRT), and 44Gy (PRT) and cochlear mean dose were 43 Gy (IMRT), 49 Gy (3DCRT), and 31Gy (PRT). Dose to several other critical structures were also significantly reduced including the whole brain, supratentorium, cerebellum, and pituitary. CONCLUSIONS: Proton therapy greatly reduces dose to critical CNS structures when compared to IMRT or 3DCRT. Further studies are needed to correlate dose reductions in these structures with improved cognitive outcomes.

RONC-31. ADVANCED ECHOCARDIOGRAPHY WITH MYOCARDIAL-STRAIN-ANALYSIS DESCRIBES SUBCLINICAL CARDIAC DYSFUNCTION AFTER CRANIOSPINAL IRRADIATION (CSI) IN PEDIATRIC AND YOUNG ADULT PATIENTS WITH CENTRAL NERVOUS SYSTEM (CNS) TUMORS

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CSI is part of the treatment of CNS tumors and is associated with cardiovascular disease; data in pediatric/young-adult patients are limited. Myocardial-strain-analysis can reveal subclinical dysfunction. Retrospective,

single-center study in CNS tumor patients managed with CSI from 1986–2018. Clinical details, and echocardiography including myocardial-strain-analysis were collected at T1=first echocardiogram after CSI, and T2=most recent echocardiogram. Data are mean±standard deviation. Echocardiograms were available in 44 patients (36%female, 14±8.0years) at T1 and 39 patients (38%female, 21.0±11.3years) at T2. Standard echocardiography was normal for all subjects. At T1, global longitudinal peak systolic strain (GLS) was -16.3%±3.7% in CSI vs. -21.6%±3.5% in controls ($p<0.0001$); global radial peak systolic strain (GRS) was 21.5%±10.1% in CSI vs. 26.5%±7.4% in controls, and global circumferential peak systolic strain (GCS) was -19.5%±6.0% in CSI vs. -21.4%±3.4% in controls ($p<0.05$, both comparisons). At T2, GLS was -15.8%±5.2% in CSI vs. -21.9±3.5% in controls ($p<0.0001$); GRS was 22.6%±10.4% in CSI vs. 27.1±8.2% in controls ($p<0.05$); GCS was -20.5%±6.9% in CSI vs. -21.8±3.5% in controls ($p=0.10$). For 17 patients with myocardial-strain-analysis available for both time points: difference in GLS was 0.06±7.2% ($p>0.95$); GRS was 5.5±9.5% ($p<0.05$); GCS was -3.4±4.9% ($p<0.05$). Subclinical dysfunction is present at first echocardiogram after CSI. Myocardial impairment may recover with time, however further analysis is needed to identify risk factors and trends. These results argue for inclusion of baseline cardiovascular assessment and longitudinal follow-up in CNS tumor patients post CSI.

RONC-32. LOCAL CONTROL FOLLOWING PROTON THERAPY FOR PEDIATRIC CHORDOMA

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BACKGROUND: Due to the location and high dose required for disease control, pediatric chordomas are theoretically well-suited for treatment with proton therapy, but their low incidence limits the clinical outcome data available in the literature. METHODS AND MATERIALS: Between 2008 and 2019, 29 patients with a median age of 14.8 years (range, 3.8–21.8) received proton therapy for non-metastatic chordoma at a single institution. Twenty-four tumors arose in the clivus/cervical spine region and 5 in the lumbosacral spine. Twenty-six tumors demonstrated well-differentiated histology and 3 were dedifferentiated or not otherwise specified (NOS). Approximately half of the tumors underwent specialized testing: 14 were brachyury-positive and 10 retained INI-1. Seventeen patients had gross disease at the time of radiation. The median radiation dose was 73.8 GyRBE. RESULTS: With a median follow-up of 4.3 years (range, 1.0–10.7), the 5-year estimates of local control, progression-free survival, and overall survival rates were 85%, 82%, and 86%, respectively. Excluding 3 patients with dedifferentiated/NOS chordoma, the 5-year local control, progression-free survival, and overall survival rates were 92%, 92%, and 91%, respectively. Serious toxicities included 3 patients with hardware failure or related infection requiring revision surgery, 2 patients with hormone deficiency, and 2 patients with Eustachian tube dysfunction causing chronic otitis media. CONCLUSION: In pediatric patients with chordoma, proton therapy is associated with a low risk of serious toxicity and high efficacy, particularly in well-differentiated tumors. Complete resection may be unnecessary for local control and destabilizing operations requiring instrumentation may result in additional complications following therapy.

NEUROSURGERY

SURG-02. INITIAL MANAGEMENT OF HYDROCEPHALUS IN THE PEDIATRIC AND YOUNG-ADULT PATIENTS WITH BRAIN TUMORS; THE EFFICACY OF LONG-TERM INDWELLING EXTERNAL VENTRICULAR DRAINAGE

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BACKGROUND: Pediatric and Young-Adult (AYA) brain tumors often present with hydrocephalus. As temporary cerebrospinal fluid (CSF) diversion procedure, we perform long-term indwelling external ventricular drainage (EVD) in the case of the management of CSF diversion more than two weeks presumably. The aim of this study is to investigate the initial management for hydrocephalus in pediatric /AYA patients with brain tumor, especially about long-term EVD. MATERIALS AND METHODS: The patients less than 30 years of age diagnosed with brain tumor between 2005 and 2019 were retrospectively analyzed. Procedures of long-term EVD were similar to that of ventriculoperitoneal shunt (VPS) operation. Using flow-control VPS system, peritoneal catheter passed out of the body at the anterior chest, and distal end of the catheter was connected to standard EVD system. RESULTS: In total of 345 patients with brain tumor, 109 had hydrocephalus at presentation. Among them, 25 patients (23%) underwent long-term EVD. The main reasons for selecting long-term EVD were to avoid intraperitoneal dissemination (n=13), and to maintain longer period of CSF diversion for the treatment of tumor (n=12). The median of long-term EVD was 38 days (range: 12 – 222 days). Although one case suffered from drainage tube occlusion at 59 days, there were no other complications such as infection or accidental evulsion. Eventually, 3 cases required permanent VPS for persistent hydrocephalus. CONCLUSION: Long-term EVD is safe and effective option for CSF diversion. This procedure should be taken into consideration if patients have a risk of dissemination and may elude permanent VPS.

SURG-03. IMMERSIVE VIRTUAL REALITY APPLICATIONS IN NEUROSURGICAL ONCOLOGY

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Tridimensional (3D) rendering of volumetric neuroimaging is increasingly been used to assist surgical management of brain tumors. New technologies allowing immersive virtual reality (VR) visualization of obtained models offer the opportunity to appreciate neuroanatomical details and spatial relationship between the tumor and normal neuroanatomical structures to a level never seen before. We present our preliminary experience with the Surgical Theatre, a commercially available 3D VR system, in 60 consecutive neurosurgical oncology cases. 3D models were developed from volumetric CT scans and MR standard and advanced sequences. The system allows the loading of 6 different layers at the same time, with the possibility to modulate opacity and threshold in real time. Use of the 3D VR was used during preoperative planning allowing a better definition of surgical strategy. A tailored craniotomy and brain dissection can be simulated in advanced and precisely performed in the OR, connecting the system to intraoperative neuronavigation. Smaller blood vessels are generally not included in the 3D rendering, however, real-time intraoperative threshold modulation of the 3D model assisted in their identification improving surgical confidence and safety during the procedure. VR was also used offline, both before and after surgery, in the setting of case discussion within the neurosurgical team and during MDT discussion. Finally, 3D VR was used during informed consent, improving communication with families and young patients. 3D VR allows to tailor surgical strategies to the single patient, contributing to procedural safety and efficacy and to the global improvement of neurosurgical oncology care.

SURG-04. THE APPLICATION OF EN BLOC RESECTION IN THE OPERATION OF PEDIATRIC POSTERIOR FOSSA TUMOR

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OBJECTIVE: To explore the efficacy and safety of en bloc resection therapy on posterior fossa tumor in children. METHODS: A retrospective analysis was conducted on the clinical data of 94 patients with posterior fossa tumor admitted to Department of Pediatric Neurosurgery, Xinhua Hospital Affiliated to Shanghai Jiaotong University School Of Medicine from January 2018 to December 2019. Among them, 35 cases were treated with traditional resection (control group) and 59 cases with en bloc resection (observation group). We counted the amount of blood loss and the time during tumor resection, We compare the symptoms and signs between the two groups and determine a extent of tumor resection based on microscopic observation and preoperative and postoperative imaging comparison. RESULT: The total tumor resection rate of the observation group (88.1%, 52 / 59) was significantly higher than that of the control group (62.85%, 22 / 35, $P < 0.05$). The average bleeding volume of 90.8ml in the observation group was significantly smaller than that of the control group (113.3ml, $P < 0.05$), and the average operation time of 38.6min in the observation group was shorter than that of the control group (57.4min, $P < 0.05$) only for tumor resection procedure. CONCLUSION: En bloc resection technique can effectively accelerate the resection time, reduce intraoperative bleeding and improve the total resection rate of tumors in children's posterior cranial fossa.

SURG-05. AN AWAKE SURGERY FOR A CHILD SUFFERING FROM EPILEPSY DUE TO DYSEMBRYPLASTIC NEUROEPITHELIAL TUMOR LOCATED IN THE LEFT PARIETAL LOBE

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