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Dosimetric Evaluation of Anterior Visual Pathway Structures I.E Optic Nerve and Chiasma in Adjuvant Radiation Therapy of Glial Tumors Treated Using Intensity Modulated Radiation Therapy- An Observational Study

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Abstract:-

- ***Background:***

In the treatment of glial tumors, intensity-modulated radiation therapy (IMRT) reportedly reduces the high-dose irradiation of at-risk organs and decreases the frequency of adverse events (AEs).The dosimetric parameter maximum dose (Dmax) received by the optic structures influence the incidence and severity of radiation-induced optic neuropathy in patients treated with radiotherapy to brain. In this study we evaluate the Dmax and adjust measures in treatment planning in such a way as to reduce the dose received by the optical structures.

- ***Method:***

Thirty patients aged between 21-68 diagnosed with primary intracranial gliomas were included in this study. It was a hospital based retrospective, dosimetric, observational study. Purposive sampling method was used for all the cases of Glioma during the study period, who meet the inclusion criteria and the mean of Dmax was calculated.

- ***Result:***

Mean of Dmax of all patients were found to be within the normal limit according to RTOG Dose constraints

- ***Conclusion:***

In this observational study, the maximum dose delivered to optic structures such as the optic nerve and chiasma were within tolerable limits. The occurrence of radiation-induced optic neuropathy in such patients will be highly unlikely. Therefore, intensity modulated radiation therapy is the best and preferred modality for the treatment of glial tumors.

I. INTRODUCTION

Gliomas are primary brain tumors thought to originate from neuroglial stem or progenitor cells. Based on their histological appearance, they have traditionally been classified as astrocytic, oligodendroglial, or ependymal tumors and assigned WHO grades I-IV, indicating varying degrees of malignancy. Malignant or high-grade gliomas account for approximately half of all primary brain tumors in adults. They are fast-growing tumors that directly invade the brain parenchyma, but almost never metastasize outside the CNS. They occur in any age group, although most occur in late adulthood. Malignant gliomas correspond to anaplastic gliomas (WHO grade III) and GBM (WHO grade IV). Glioblastoma (GBM) accounts for approximately 75% of all high-grade gliomas. Standard treatment consists of maximum safe surgical resection followed by concurrent TMZ chemotherapy and subsequent adjuvant TMZ chemotherapy. The current "standard approach" delivers a total dose of 59.4 to 60 Gy in 30 to 33 fractions of 1.8 to 2 Gy/fraction, using a "shrinking field" technique.

The optic nerve exhibits toxicity months to years after RT, with a peak incidence at 18 months. Radiation-induced optic neuropathy (RION) is a devastating late complication of anterior optic pathway radiotherapy leading to acute, profound, irreversible vision loss. It is thought to be the result of radiation necrosis of the anterior visual pathway. Vision loss can be unilateral or bilateral; simultaneous or sequential. Because RION commonly occurs between 10-20 months, on average 18 months after treatment; but onset can range from three months to 9 years. Cumulative doses of radiation in excess of 50 Gy or single doses to the anterior optic tract or greater than 10 Gy are usually required to develop RION. Several factors are associated with a higher risk of developing RION or RION occurring at lower total radiation doses. These include age, preexisting compression of the optic nerve and chiasm by tumor, concurrent chemotherapy, or previous external radiation. MRI, the examination of choice to identify radiation damage to the optic pathway, can show abnormalities before vision loss. Unenhanced T1- and T2-weighted images usually show no abnormality, but the optic nerve will show enhancement on T1-weighted images with MRI. Treatment with systemic corticosteroids, anticoagulation, and hyperbaric oxygen was generally unsuccessful and unsatisfactory. If visual dysfunction is detected early, hyperbaric oxygen may be beneficial if treatment is initiated within 72 hours of vision loss. Since no effective therapy is known for RION, optic nerve minimization requires sophisticated treatment planning to minimize treatment volume, total dose, and especially dose per fraction

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The primary objective of this study is to evaluate the dosimetric parameter maximum dose (Dmax), which may influence the incidence and severity of radiation-induced optic neuropathy in glioma patients treated with radiotherapy.

The secondary goal is to adjust measures in treatment planning in such a way as to reduce the dose received by the optical structures and thereby reduce the incidence of optic neuropathy and improve the quality of life of patients.

II. MATERIALS & METHODS

- *Patients:*

From January 2021 to December 2021, 30 patients with gliomas were enrolled. Inclusion criteria were patients with histologically confirmed intracranial gliomas, patients with gliomas who underwent surgery. Glioma patients treated with adjuvant radiation therapy after tumor bed OP. Glioma arising from the frontal, fronto temporal or fronto parietal region, ECOG score </=2. Patients undergoing radiation therapy with palliative intent, whole brain irradiation, glioma arising from the occipital region, brain metastatic lesions, non-glial brain tumors, patients with metastatic disease, prior radiation therapy, any other active malignancy within the past five years, and a performance status (PS) > 2 on the ECOG scale were excluded. Each patient underwent a baseline laboratory examination, MRI Brain, contrast computed tomography (CECT) of the head and neck before starting treatment. The median age was 44 years (21-68 years).

- *Radiation therapy and dose-volume parameters:*

Contrast-enhanced computed tomography (CT) for treatment planning was performed from the vertex to mid-thigh with a slice thickness of 3 mm. Intensity Modulated Radiation Therapy (IMRT) treatment plans were created using a treatment planning system on an ELEKTA linear accelerator with a dose calculation algorithm and 6MV x-rays. Patients are scheduled with a total dose of 59.4 Gy in 33 fractions, used as a prescribed dose with a daily dose of 1.8 Gy fractions using the IMRT technique.

Organs at risk (OAR) include bilateral optic nerves, optic chiasma, and bilateral eyes and lens. The dosimetric parameter - the maximum dose (Dmax) received by the optical structures was estimated from the dose volume histogram (DVH) data.

Chemotherapy was given concurrently with radiation therapy every day on RT days with a capsule of temozolamide. Patients were assessed for hematological, biochemical, metabolic and cardiovascular status before and after the cycle of chemotherapy

III. RESULT

Of the 30 cases analyzed, 60 percent were men and 40 percent were women. The minimum age was 21 years, the maximum age was 68 years, and the median age was 44 years. Histopathological specimens revealed that 80 percent were GBM patients, 20 percent were III gliomas. grades (anaplastic oligodendroglioma, anaplastic astrocytoma, ependymoma)

RT dose: Dmax to optic nerve: According to RTOG guidelines: < 55 Gy. In this study, the mean is 20.58. 1 in 30 patients received more than >55 Gy to the right optic nerve and 1 in 30 patients received more than >55 Gy to the left optic nerve, putting them at risk of developing late adverse events.

RT dose: Dmax to the optic chiasma - according to RTOG guidelines: Dmax <56Gy. The average dose in the above patients is 31.85 Gy. 0 patients received more than 56 Gy and therefore had no risk of developing this late optic nerve reaction

IV. DISCUSSION

Radiation-induced optic neuropathy (RION) is a devastating late complication of anterior optic pathway radiotherapy leading to acute, profound, irreversible vision loss. In a review by Mayo Clinic investigators, the risk of RION was almost nil at conventionally fractionated doses ≤ 50 Gy and still rare at maximum dose < 55 Gy. The risk of RION increases from 3% to 7% at 55 to 60 Gy and is substantial (> 7% to 20%) at doses > 60 Gy. In a series of 131 patients (215 optic nerves) treated with RT for extra cranial head and neck tumors, Parsons found no RION in nerves that received <59 Gy. Fraction size was of primary importance: In cases where >60 Gy was received, fraction size was more important than total dose in RION production. Therefore, it is important to evaluate predictors of optic nerve and chiasmal doses for late optic nerve pathway responses. Farzin et al demonstrated that the low percentage of cases with radiation-induced high optic toxicity indicates that modern treatment techniques and doses are safe.

This study identified optic nerve and chiasmatic Dmax dosimetric parameters that may be relevant in assessing the incidence of radiation-induced optic neuropathy in patients receiving radiation therapy for gliomas. Given the number of optic pathway dosimetric parameters that have been shown to correlate with optic neuropathy, the development of clinically useful rules to help clinicians estimate treatment-related adverse events should now be considered a priority for any future research. However, any future evaluation of these dosimetric parameters in the future literature should not only report the correlation but also assess the operational characteristics of the recommended parameter cutoffs.

V. CONCLUSION

In this observational study, the maximum dose delivered to optic structures such as the optic nerve and chiasma were within tolerable limits. The occurrence of radiation-induced optic neuropathy in such patients will be highly unlikely.

Therefore, intensity modulated radiation therapy is the best and preferred modality for the treatment of glial tumors. Regular imaging of optic structures in brain tumors regardless of location should be continued to avoid the risk of developing RION.

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