Case Report

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Frontal Radiation Induced Meningioma

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Abstract

Introduction: The adjuvant therapeutic radiation therapy (RT) results in the development of cranial neoplasms, though is a rare entity but a serious complication.Tthe most common form of radiation-induced neoplasm is the radiation induced meningiomas. These are the late complications in pati-ents who have received adjuvant radiation therapy for brain tumors. In 1953, Mann, et. al. first described a 4-year-old girl who was treated with 65 Gy for an optic nerve glioma developed a meningioma in the irradiated field which eventually became malignant. The most common form of the RIBT is the Meningioma as reported in the lit-erature [3]. Radiation- induced meningiomas developing after the surgical excision of medulloblastoma are seen very rarely.

Case Report: A 13-year-old male patient presented with left frontal meningioma which developed after 9 years from receiving adjuvant radiation therapy for medulloblastoma. Surgical resection and RT was applied at the age of 4 for medulloblastoma. At age of 13, the patient had features of raised ICP (Intra Cranial Pressure). A neurological examination was normal. Magnetic resonance imaging demonstrated a left frontal mass. The patient underwent left frontal craniotomy and the mass removed totally. Histopathological exami-nation revealed a meningotheliomatous meningioma.

Conclusion: The adjuvant RT given post operatively for medulloblastoma resulted in the cytological changes of tumor cells. All the cases of pediatric malignancies and those particularly exposed to adjuvant radiation therapy are advised for followup for a longer period of time as it is crucial for the early detection of the radiation induced tumors and it should be consid-ered as a part of the effective therapy of the primary disease.

Keywords: Radiation Induced Meningiomas (RIM); Sporadic Meningiomas; Medulloblastoma.

Introduction

The survival rates of the intracra-nial neoplasms following a combined treatment modality which consisted of surgery followed by radiation therapy (RT) with/without chemotherapy have improved drastically [1,2].But the complications with the adjuvant therapy were observed in these group of patients on long term followup [1,2]. Of these complications, the major complication is the development of a new primary cranial neoplasm which has been recognized as a possible late effect of curative therapy for an original childhood cancer. The patients with benign scalp lesions, benign and malignant intracranial tumors, and hematologic malignancies treated with adjuvant radiation therapy have been repoted with radiation-induced brain tumors (RIBT).

In 1953, Mann, et. al. first described a 4-year-old girl who was treated with 65 Gy for an optic nerve glioma developed a meningioma in the irradiated field which eventually became malignant. The most common form of the RIBT is the Meningioma as reported in the lit-erature [3].

Our patient to whom surgical resection and RT were applied at the age of 4 due to medulloblas-toma,

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had developed meningioma in left frontal region after 9 years from medulloblastoma treatment.

Case Report

A 4 year old male child reported to emergency department with the complaints of 4-5 episodes of vomiting for 2 days associated with altered consiousness. The child was admitted and CT scan of brain was showing a large, solid midline posterior fossa mass with obstructive hydrocephalus (Figure 1 & Figure 2). The patient underwent a Rt ventriculo-peritoneal shunt procedure in the emergency follwed by a midline suboccipital craniectomy and excision of midline SOL in 2008. The histopathological report showed a medulloblastoma (Figure 3). The patient was treated with postoperative radiotherapy for brain daily and for spine on alternate days. The patient tolerated radiotherapy well and did not have any complications. The patient followed up for 6 years and the child was asymptomatic.

In 2017 the patient again presented with vomiting for 4 days. A neurological examination was normal. MRI of brain demonstrated an well defined solid cystic lesion with perilesional oedema in left high frontal cortex (Figure 4). The patient underwent left frontotemporal craniotomy and the lesion was

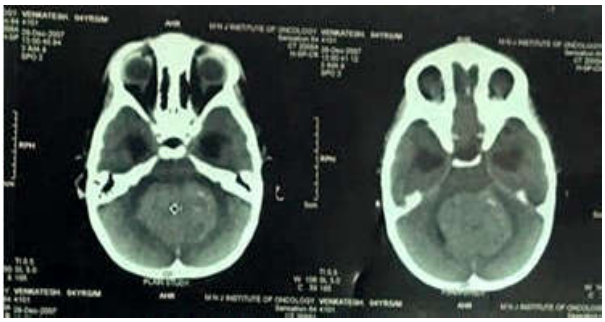

Fig. 1: A plain CT brain showing midline posterior fossa medulloblastoma

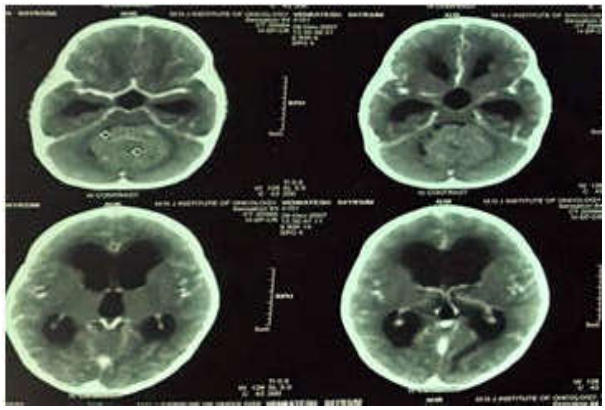

Fig. 2: A contrast CT brain showing obstructive hydrocephalus

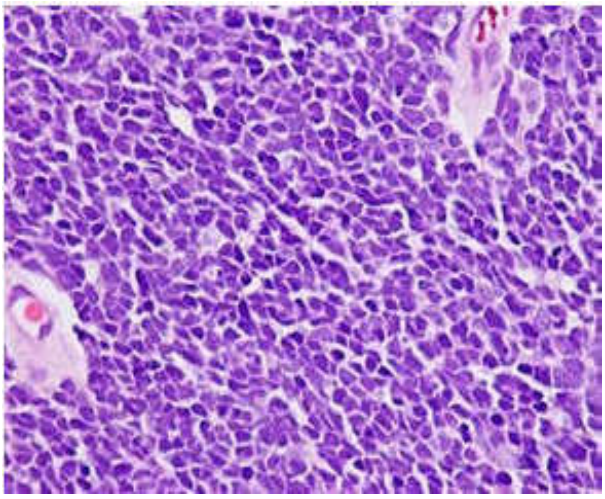

Fig. 3: Histopathological slide of medulloblastoma

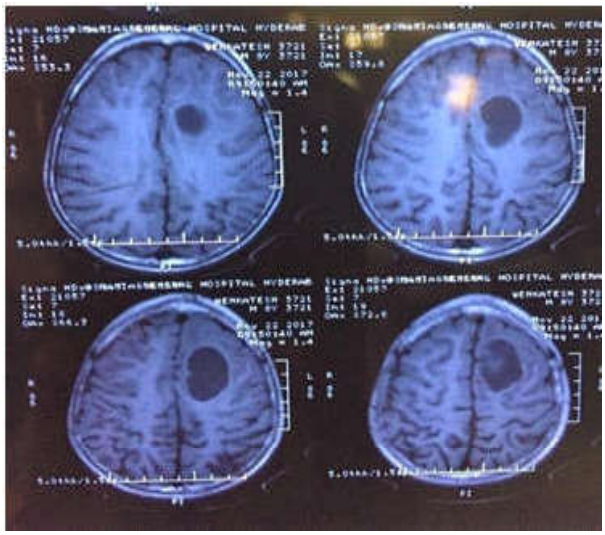

Fig. 4: A plain MRI of brain showing well defined solid-cystic lesion in left frontal cortex

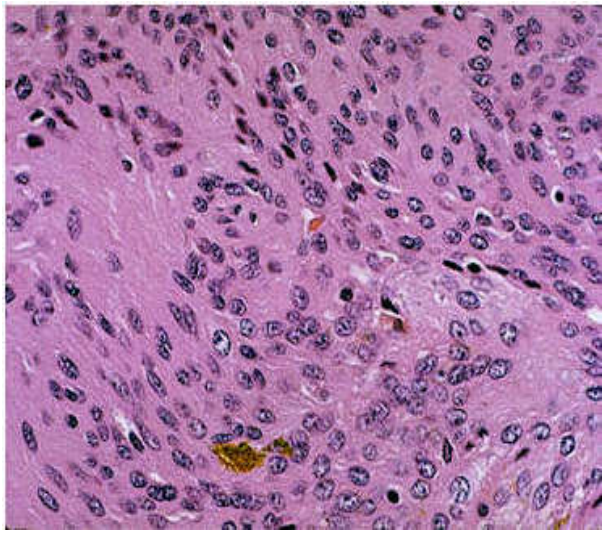

Fig. 5: Histopathological slide showing meningotheliomatous meningioma (WHO Grade I)

excised. Histopathological examination revealed a meningotheliomatous meningioma (WHO grade I) (Figure 5). The patient was discharged and is asymptomatic at 2 months followup.

Discussion

The most common cranial neoplasm developing after the adjuvant radiation is the meningioma [4]. According to Harrison et al RIMs are divided into 3 categories: those due to high-dose (> 20 Gy), intermediate-dose (10–20 Gy), and low-dose (< 10 Gy) radiation [5]. Musa et. al. defined the radiation dose of > 10 Gy as high [6].

High-Dose RIMs

In 1953, Mann et al. described a meningioma in a 4- year-old girl operated for optic nerve glioma was given adjuvant radiation therapy. After the adjuvant treatment the meningioma eventually became malignant [3]. According to Musa et al there have been up to 126 reported cases of high-dose RIMs in the literature between 1953 and 2002 [6]. The radiation doses ranged from 22 to 87 Gy, and the majority of patients had undergone radiotherapy as children. The patients who have received radiotherapy at younger ages and those treated with higher doses had a shorter mean latency from irradiation to diagnosis of the meningioma with a mean latency of ~ 19 years [5,6].

Low-Dose RIMs

The patients who had undergone radiation treatment for tinea capitis, those whose head and neck were exposed to medical and dental x-rays at a young age, and survivors of the atomic explosions in Hiroshima and Nagasaki had an increased incidence of meningiomas following exposure to low-dose radiation.

According to Cahan et al, a meningioma can be con-sidered radiation-induced: if it (1) did not exist before the irradiation, (2) developed in the pre-viously irradiated area, (3) was confirmed by histological studies, and (4) had a latency period of at least 5 years from irradiation.[7] The high sensitivity of the meningeal tissue to irradiation may be the possible pathogenesis to explain the relationship between the irradiation and the induced meningiomas. It is also hypothesized that meninges are affected by exposure to very low doses of radiation in the form of diagnostic x-ray studies and CT scanning. Furthermore, the meninges and the mesodermal tissues of the children are extremely sensitive to oncogenetic stimulus and are more vulnerable to the adverse effects of radiation [8].

In a survey of 126 cases of high-dose radiation by Strojan et al & Preston et al the reported female predominance is 1.33:1 [9,10]. The location of the RIM is primarily related to the site of exposure. According to Ghim et. al. 11 of 13 pediatric patients with high-dose RIMs had calvarial meningiomas, whereas skull base meningiomas were found in 4–19% of patients with RIM in whom there was a history of high-dose irradiation for primary brain tumors [11]. Epidemiological studies of patients with RIM linked to full-mouth dental x-rays have shown that skull base meningiomas are more common following this type of radiation exposure [12].

The latency period between exposure and clinical diagnosis of meningioma varies with radiation dose and age at initial treatment. Sadetzki et al reported a 36.3-year average latency (range 12–49 years) in the Israeli low-dose cohort study [13]. According to the thorough review of the literature by Harrison et al there is a mean latency period of 35.2 years between low dose irradiation (10 Gy) and diagnosis, whereas there is a mean latency of 26.1 and 19.5 years, respectively, in patients receiving moderate (10–20 Gy) and high-dose (20 Gy) treatment [5].

Meningotheliomatous, transitional, and fibroblastic histological subtypes are the most common in RIM. Histological features are distinctive compared with sporadic meningiomas. According to Soffer et al in a series of 42 patients with low-dose RIM on the histopathological features have noted high cellularity, nuclear pleomorphism, an increased mitotic rate, focal necrosis, bone invasion, and tumor infiltration of the brain [14]. Rubinstein et. al. also reported several findings: a high degree of cellularity; pleomorphic nuclei with great variation in nuclear size, shape, and chromatin density; numerous multinucleated and giant cells; and nuclei with vacuolated inclusions [15]. They also noted frequent mitoses, psammoma bodies, foam cells, and thickened blood vessels that did not stain for amyloid. According to Musa et al the reported incidence of atypia or malignancy among 79 cases of high-dose RIM is 23% [16].

Radiation-induced meningiomas have a more aggressive clinical behavior and high recurrence rates following surgery and radiotherapy than sporadic meningiomas [5,14]. Rubinstein et al noted a 25.6% recurrence rate in 43 patients with RIM, and 11.6% of this group experienced multiple recurrences, compared with an 11.4% recurrence rate in 258 patients with sporadic meningiomas in their series.

Both groups were followed for only 4 years [15]. Higher recurrence rates in patients with RIMs than those with sporadic meningiomas have also been reported elsewhere [13,14].

Medulloblastoma is a primitive neuronal tumor, usually arising in childhood. Treatment is surgi-cal resection followed by craniospinal RT. As the treatment of medulloblastoma improves, increased numbers of long-term survivors will be exposed to the risk of secondary neoplasms. According to Goldstein AM et al only 0.4 % of sec-ondary tumors which develop from medullo-blastoma settle in the brain and CNS [1]. In patients with medulloblastoma, the various sec-ondary tumours, meningioma, astrocytoma, oli-godendroglioma, and glioblastoma are report-ed [1,2,17]. All of the reported meningiomas that are secondary to medulloblastoma have developed because of high-dose radiation. After high-dose radiation for medulloblastoma, RIMs were described following latency periods ranging from 2.2 to 36 years. In a patient with medulloblastoma, only 36 % of meningiomas emerging after a long latency period settle in posterior fossa. The reason might be applica-tion of the whole brain irradiation apart from focal boost in the treatment of medulloblasto-ma [8].

Surgical removal is the treatment of choice for most cases of RIM, although complete and safe resection may not be possible due to the lesion's frequent multiplicity, involvement of osseous structures and vessels, and aggressive nature. Paradoxically, stereotactic radiosurgery or fractionated stereotactic radiosurgery may be appropriate adjuncts to surgery or may be performed in lieu of surgery in some patients, despite the radiation-related origins of RIMs. In some patients, angiography may be appropriate for visualization of the tumor's vascular anatomy and preoperative embolization.

Conclusion

In conclusion, RIM at children with medullo-blastoma is increasing recently, probably in rela-tion to the increased long-term survival rates in patients with medulloblastoma. When RT is indicated, use of the minimally effective dose may reduce the risk of secondary CNS neo-plasms emerging many years later. The RT given may have influenced the subsequent cytological changes of tumor cells. Prolonged follow-up of all pediatric cancer survivors, particularly those exposed to radiation, is crucial to the early detection of these tumors and should be consid-ered part of the effective therapy of the primary disease.

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