

Spectrum of Pediatric Malignancies Treated with Radiotherapy in North-East India: A Five-Year Institutional Experience**Moumita Paul¹, Apala Bhattacharjee², Ghritashee Bora³, Goutham Raj C.⁴, Smriti Goswami⁵, Luri Borah⁶**¹Assistant Professor, Department of Radiation Oncology, State Cancer Institute, Gauhati Medical College, Guwahati, Assam, India²PGT, Department of Radiation Oncology, State Cancer Institute, Gauhati Medical College, Guwahati, Assam, India³Assistant Professor, Department of Radiation Oncology, State Cancer Institute, Gauhati Medical College, Guwahati, Assam, India⁴Senior Resident, Department of Radiation Oncology, State Cancer Institute, Gauhati Medical College, Guwahati, Assam, India⁵Associate Professor, Department of Radiation Oncology, State Cancer Institute, Gauhati Medical College, Guwahati, Assam, India⁶Assistant Professor, Department of Radiation Oncology, Nalbari Medical College, Assam

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Abstract

Background: Childhood cancers, though relatively uncommon, represent a significant cause of morbidity and mortality worldwide. In India, where pediatric cancers constitute less than 5% of the overall cancer burden, regional disparities in access to diagnosis and treatment persist. The North-Eastern region, with its distinctive demographic and healthcare landscape, remains particularly underrepresented in pediatric oncology literature. Data on children receiving radiotherapy, an integral component of multimodal cancer care, are especially limited in this part of the country. This study was undertaken to address this gap by evaluating the clinical and demographic characteristics of pediatric cancer patients receiving radiotherapy at a tertiary care center in North-East India.

Materials and Methods: A retrospective, cross-sectional study was conducted on pediatric patients aged 0–18 years who underwent radiotherapy between January 2019 and December 2023. Patient demographics, tumour characteristics, treatment intent, and anesthesia use were collected and analyzed descriptively.

Results: Among 94 patients analyzed, 58.5% were male and the largest age group was 14–18 years (36%). Hematological malignancies were most frequent (53.1%), predominantly B-cell acute lymphoblastic leukemia (B-ALL; 40.4%), followed by central nervous system tumours (29.7%). Prophylactic radiotherapy was delivered in 45% of cases, adjuvant in 37.2%, and definitive in 15%. Most patients were from Lower Assam (50%), and only 17% required anesthesia, reflecting good compliance among older children.

Conclusion: This study provides valuable insight into the spectrum of pediatric malignancies treated with radiotherapy in North-East India. Hematological cancers, particularly B-ALL, predominated, with prophylactic radiotherapy being the most common treatment intent. The findings underscore the urgent need to strengthen pediatric oncology infrastructure, incorporate advanced radiotherapy techniques, and develop region-specific treatment protocols to improve childhood cancer outcomes in this underserved region.

Keywords: Pediatric oncology, Radiotherapy, B-cell acute lymphoblastic leukemia, North-East India, Treatment patterns, Hematological malignancies.

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Introduction

Childhood cancers rank ninth globally as a leading cause of childhood diseases that account for 11.5 million (10.6–12.3 95% CI) of the Disability Adjusted Life Years (DALYs') [1]. Childhood cancer ranked fifth in 2017 as a leading cause of

death among children between 5 and 14 years [2]. According to a recent National Cancer Registry Programme (NCRP) report in India, childhood cancers accounted for 4.0% of all cancers in the 0–14 age group [3].

Childhood cancer accounts for <5% of the total cancer burden in India and approximately 45,000 new childhood cancer cases are diagnosed every year [4,5]. Developed countries on the other hand have better cure rates of childhood cancers than in India [6,7]. This is because of the lack of dedicated pediatric oncology centers and a paucity of data on pediatric cancers in our country. Lack of a specific programme component or policy to address childhood cancer control also play a primary role in attributing to the emerging concern about the childhood cancers in India.

Cancers of the eye and lymphoid leukaemia contributed to the highest disability-adjusted life years (DALYs) in 2016 among children in the 0–14 age group [8]. Childhood cancers need aggressive management by multimodal therapy with close collaboration among the pediatric surgeons, radiation oncologists and medical oncologists. The use of radiotherapy in the clinic has now varied over time with the advent of chemotherapy and advanced surgical techniques. The epidemiological data on pediatric oncology patients undergoing radiotherapy in the North-Eastern region of India remains scarce. Recognizing this gap, the present study was undertaken to comprehensively evaluate the clinical profile of pediatric cancer patients attending the Radiation Oncology clinic and receiving radiotherapy, with the aim of contributing valuable insights to the limited existing literature.

Materials and Methods

Study Design: This is a retrospective cross – sectional observational study conducted in a tertiary care institute in North Eastern India. The study was conducted in the Department of Radiation Oncology.

Sample size: A total of 94 pediatric patients were included in the study.

Primary and Secondary outcomes: The primary outcome of this study was to characterise the spectrum and distribution of pediatric malignancies treated with radiotherapy at the institution during the study period along with patient demographic characteristics. Secondary objectives included evaluation of radiotherapy treatment parameters including intent and technique of treatment assessment of feasibility related factors like the requirement of anesthesia during radiotherapy and the occurrence of treatment interruptions or breaks.

Inclusion criteria: All paediatric patients between the ages of 0-18 years were enrolled who received radiotherapy from 1st January 2019 to 31st December 2023.

Exclusion criteria: Exclusion criteria included patients older than 18 years and the ones lesser than

18 years who were referred but did not receive radiotherapy.

The treatment records were carefully retrieved and the following variables were taken into consideration for the study: patient particulars, diagnosis of the patient, site of disease, radiotherapy treatment details (including intent, technique, and machine), use of anesthesia, treatment breaks if any.

Ethics: Ethical approval for the study was obtained from the Institutional Ethics Committee of the State Cancer Institute, Gauhati Medical College, Guwahati. The committee reviewed and approved the study protocol in its meeting held on 12 April 2024 (Approval No. SCI/GMC/ECR/2120/135, dated 23 April 2024). As this was a retrospective study involving anonymized patient data, the requirement for informed consent was waived by the committee.

Results

A total of 94 patients of age upto 18 years attended the Radiation Oncology clinic over 5 years duration (2019-2023) were analyzed, out of which 90 patients completed the whole radiotherapy course and 4 patients defaulted treatment.

The clinical and demographic characteristics of the patients have been shown in Table 1. The age distribution revealed that the majority of patients (36%) were in the 14–18 years age group, followed by 25.5% each in the 4–8 years and 9–13 years age groups, and 12.7% in the 0–3 year's group.

Among the pediatric patients analyzed, hematological malignancies were the most frequently encountered, comprising 53.1% of all cases, with Acute Lymphoblastic Leukemia (ALL) representing the predominant subtype. Central nervous system (CNS) tumours were the second most common, observed in 29.7% of patients. Tumours of the head and neck region and, soft tissue sarcomas, and bone tumours each accounted for 7.4% of cases, while 2.1% had tumours in other sites.

With regard to treatment intent, prophylactic radiotherapy comprised the largest proportion, administered to 45% of patients. Adjuvant and definitive treatments were delivered to 37.2% and 15% of cases, respectively, whereas neoadjuvant therapy and palliative radiotherapy were utilized in 2% and 1% of patients, respectively. In terms of regional representation, the majority of patients were from Lower Assam (50%), followed by North Assam (17%), Upper Assam (14.9%), and Central Assam (13.8%), while smaller proportions were recorded from the Barak Valley (1.1%) and other regions (3.2%).

Gender-wise, 58.5% of the patients were male, while 41.5% were female. Some proportion of patients required anesthesia for radiation treatment.

16 patients (17%) required anesthesia during radiation, whereas majority did not require it.

Table 1: Table showing demographic and clinical characteristics of patients

Age Group	Number	Percentage Of Total (%)
0-3	12	13
4-8	24	25.5
9-13	24	25.5
14-18	34	36
Site		
Haematological	47	53.1
CNS	29	29.7
Head & Neck	8	7.4
Soft Tissue Sarcoma & Bone Tumours	7	7.4
Others	3	2.1
Intent of Treatment		
Prophylactic	42	44.7
Definitive	14	14.9
Adjuvant	35	37.2
Neoadjuvant	2	2.1
Palliative	1	1.1
Region		
Lower Assam	47	50
Upper Assam	14	14.9
Central Assam	13	13.8
North Assam	16	17
Barak Valley	1	1.1
Others	3	3.2
Gender		
Male	55	58.5
Female	39	41.5
Anesthesia		
No. of patients requiring anesthesia	16	17%
No. of patients not requiring anesthesia	78	83%

B-cell acute lymphoblastic leukemia (B-ALL) was the predominant diagnosis, comprising 40.4% of cases, followed by nasopharyngeal carcinoma (7.4%) and central nervous system tumours such as ependymoma, craniopharyngioma, brainstem glioma, and astrocytoma (each 5.3%). Less common malignancies included T-cell ALL (4.3%), oligodendroglioma, medulloblastoma, and Hodgkin's lymphoma (each 3.2%), with a variety of rare tumours collectively representing 1–2% of cases. Table 2 shows the different tumour variants treated with radiotherapy.

Four patients (4.2%) discontinued radiotherapy after receiving partial treatment fractions, primarily due to socioeconomic barriers, travel difficulties, treatment-related fatigue and toxicity.

Discussion

This study analyzed the clinical and demographic patterns of pediatric oncology patients receiving radiotherapy. The most common age group in this study was 14–18 years (36.1%), followed by 4–8

years (25.5%) and 9–13 years (25.5%). These findings correlates with the age distribution reported by Arora et al, who observed a higher incidence of radiotherapy use in adolescents due to the delayed diagnosis often associated with older children. In contrast, Gupta et al, V. Suhag et. al found a slightly younger peak age (9–13 years), which may reflect differences in referral patterns or access to diagnostic facilities[9-11].

The majority of patients had haematological malignancies which was seen in more than half of the population (53.1%), followed by central nervous system (CNS) tumours (29.7%). This distribution correlates with data from the Indian Pediatric Oncology Database and by studies by V. Suhaget.al, Vinin et.al, where haematological malignancies also dominate the paediatric cancer spectrum [11,12]. However, CNS tumours formed a higher percentage in studies from Western countries (Smith et al.), likely due to earlier imaging access and higher awareness, suggesting a regional disparity in tumour detection [13].

With regard to treatment intent, prophylactic radiotherapy was administered to approximately 45% of patients, followed by adjuvant (37%) and definitive (15%) treatments. This distribution contrasts with findings from Suhag et al. and Vinin

et al. [11,12], where definitive and adjuvant radiotherapy were more prevalent, possibly reflecting differences in the types of tumours commonly encountered across centers.

Table 2: Table showing frequency of different tumours which received radiotherapy

Diagnosis	Number	Percentage Of Total (%)
B-ALL	38	40.4
Ca Nasopharynx	7	7.4
Ependymoma	5	5.3
Craniopharyngioma	5	5.3
Brainstem Glioma	5	5.3
Astrocytoma	5	5.3
T-cell ALL	4	4.3
Oligodendroglioma	3	3.2
Medulloblastoma	3	3.2
Hodgkin's Lymphoma	3	3.2
Glioblastoma	2	2.1
Ewing's Sarcoma	2	2.1
Synovial Cell Carcinoma	1	1.1
Schwannoma	1	1.1
Pineal Gland Tumour	1	1.1
Non-Hodgkin's Lymphoma	1	1.1
Malignant Phylloides of Breast	1	1.1
Giant Cell Tumour	1	1.1
Desmoid Fibromatosis	1	1.1
Dermatofibrosarcoma Protuberans	1	1.1
Ca Rectum	1	1.1
Ca Parotid	1	1.1
Burkitt's Lymphoma	1	1.1
Aneurysmal Bone Cyst	1	1.1

Half of the patients originated from Lower Assam, aligning with the hospital's expected catchment area. The extent of regional representation fluctuates across different studies, influenced by factors such as population density and established referral networks.

The gender distribution showed a male predominance (58.5%), in line with national cancer statistics from the Indian Council of Medical Research and by studies of Suhag et. al [11,14]. This may be also affected by societal biases favouring male healthcare access, as seen in several Indian studies like Sen et al, 2020[15]. Out of total patients only 16 patients required anesthesia, suggesting good compliance among older children correlating with studies by Vinin et.al in which 27% of patients required anesthesia. But, a study by Kim et al reported higher anesthesia rates in younger children, indicating that our age profile may have decreased the anesthesia burden [16].

Four patients (4.2%) defaulted after receiving partial fractions of radiotherapy. The reasons for treatment discontinuation were multifactorial, including socioeconomic constraints, long travel

distances from rural areas, treatment-related toxicities, and limited awareness of the importance of completing therapy. These are seen to be the factors commonly reported in pediatric oncology settings across low- and middle-income regions. These factors have been well documented specifically for patients from North-East India which substantially increase the risk of treatment default [17].

With the evolving treatment techniques in pediatric oncology, advances in radiotherapy such as proton beam therapy, intensity-modulated radiotherapy (IMRT), and stereotactic radiosurgery (SRS) offer improved therapeutic outcomes. These techniques enables for precise targeting of tumour, sparing surrounding healthy tissues—an essential factor in growing children to reduce long-term side effects such as neurocognitive decline, endocrinopathies, and secondary malignancies. FLASH radiotherapy where ultra-high dose rate is used is highly promising in pediatric oncology with its advantage of sparing normal tissue while maintaining tumour control[18].The incorporation of image-guided radiotherapy (IGRT) and adaptive planning can enhance treatment effectiveness by continuously

adapting to anatomical changes that occur throughout therapy[19].

Conclusion

This study offers a comprehensive overview of the clinical and demographic characteristics of pediatric cancer patients undergoing radiotherapy at a tertiary care center in North-East India. The analysis reveals that hematological malignancies, particularly B-cell acute lymphoblastic leukemia (B-ALL), constituted the most common indication for radiotherapy, followed by central nervous system tumours. A significant proportion of cases received prophylactic radiotherapy, reflecting the prevailing regional treatment practices and the pattern of malignancies typically observed in this part of the country. The results highlight the urgent need to strengthen healthcare infrastructure, integrate advanced radiotherapy modalities, and establish dedicated pediatric oncology services to enhance treatment quality and clinical outcomes for children with cancer in the North-Eastern region of India.

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