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RADIATION ONCOLOGY AND ITS ROLE IN CANCER TREATMENT IN RURAL CANCER PATIENTS OF A CANCER CENTRE OF EASTERN INDIA: EVALUATING FEASIBILITY, COST-BENEFIT AND OUTCOMES.

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Abstract

BACKGROUND: Cancer has become a major health problem in rural India, where a shortage of healthcare services exacerbates the impact of the disease. Radiation therapy is critical in the treatment of cancer; however, its underuse in rural settings largely results from financial, logistical, and psychosocial constraints.

AIMS AND OBJECTIVES: The purpose of this study was to assess the accessibility, efficacy, and socio-economic effect of radiation therapy among cancer patients in rural India.

METHODOLOGY: A retrospective cohort analysis compared 1,240 cancer patients and their treatment outcomes and cost benefit by data collection from departmental record files and contact details of the patients registered at our cancer centre in the year 2021.

RESULT: According to the findings, 570 of the patients were treated with radiation therapy and had 3-year survival rates of 70% in cases of breast cancer patients treated with radical radiation. Cost and fear of side effects were the two major reasons for refusing treatment.

CONCLUSION: The study showed that expanded radiation therapy access in rural areas is attainable by overcoming infrastructural shortcomings, cutting down economic expenses, and offering psychosocial support for better patient education and treatment compliance. The findings emphasize the need for embracing strategic interventions towards enhancing healthcare provision and the uptake of treatment in rural areas.

Keywords: Radiation Oncology, Rural Healthcare, Cancer Treatment, Socio-economic Barriers, Treatment Access.

Introduction

In India, cancer is an actual social health concern, and the incidence and mortality rates have been increasing [1]. Cancer burden is enhanced in the rural context and the backward parts due to lack of access to health care services and poor medical infrastructure, and socio-economic conditions [2]. The estimate shows that over 1 million new cancer cases are reported annually in India (the rural

population closely follows), according to the current trend [3]. It has been documented that breast, cervical, lung, and head and neck cancer are the most common in these locations, and treatment requires a sophisticated form of intervention such as surgery, chemotherapy, and radiation [4]. As a major modality in the treatment of most cancers, radiation oncology plays an important role in augmenting any type of survival and quality of life [5]. Radiation therapy is insufficient in rural India because of multiple reasons, among them being economic, transport, and the availability of supplementary radiotherapy systems [6]. These barriers cause a broad treatment gap, thereby causing delays in the diagnosis and treatment of cancer patients within such regions [7]. The role of radiation oncology in cancer management in rural India has gained increased focus over the last few years [8]. Previous studies have highlighted the usefulness of radiation therapy to treat cancers like breast, cervical, and head and neck cancers, and many other types [9]. The clinical outcome study of urban centres has shown that there have been enhanced survival rates and better local tumor control due to the assistance of radiation therapy. In rural settings, it is a challenging situation as there are logistical and financial constraints [10]. Radiation therapy is not readily available in rural India, where people go to a far location to receive the therapy. A study has indicated that the distance to the closest radiation centre is up to 100 kilometers, a distance that is difficult to access for many patients through frequent traveling [11]. Poverty also plays a role as the costs of travelling, treatment, and overnight stay for a month are prohibitively high for the rural population [12]. In addition, fear of side effects is often cited by numerous patients, causing them to fear taking radiation therapy despite a prescription by a doctor [13]. A few of these studies have tried to explore the socio-economic and psychosocial factors that influence the treatment modes of cancer patients in a rural setup [14]. Among the prominent obstacles produced, some can be the economic loss associated with the lost wages (long treatment), absence of care support systems, and the shortage of information concerning the benefits and hazards of the radiation therapy [15, 16]. These are to be held liable for the rejection and abandonment of radiation therapy by a considerable majority of patients, which would otherwise have been life-saving [17]. Radiation oncology constitutes a poorly defined method of treating patients with cancer in rural India [18]. Financial constraints, logistic conditions, lack of health facilities, and psychosocial barriers are other factors that negatively affect the proper use of radiation therapy in rural districts [19]. Also under study is the issue of cost-benefit of being divided, the likelihood of survival, and the side effects of radiation therapy in rural places [20]. Such considerations are crucial in the creation of efficient guidelines to shrink the treatment gap and provide care to the rural Indian cancer patients [21].

The objective of this study is to evaluate the cost-effectiveness, practicability, and treatment response of radiation treatment for cancer patients in rural India. This entails assessing the accessibility and availability of radiation therapy in rural settings, considering the logistical costs and costs of providing the treatment, and assessing the outcomes of radiation therapy on survival in prevalent cancers like breast, cervical, and head and neck cancer. The study also aims to investigate the economic consequences of radiation therapy, including both direct and indirect expenses, like lost income and transport costs. In addition, it seeks to determine the psychosocial determinants driving patient preference for radiation treatment in the modes of fear of side effects, unendorsed by caregivers, and limited resources, and to evaluate the overall effectiveness of radiation treatment in disease management and side effect profiles, specifically among rural patient populations.

Materials and Methods:

Study Design:

The study employs a retrospective cohort design, collecting information for cancer patients who had previously received radiation therapy registered in our department within the year 2021. A retrospective design allows observation of available medical records to assess the result of treatment, patient characteristics, and reasons for refusal to receive treatment. The information was gathered from one hospital or radiation oncology centre serving a rural population. By separating patients who were either prescribed radiation therapy or refused it, this design facilitates a detailed analysis of the determinants of treatment access and survival and how these influence quality of life. This approach

provides a comprehensive overview of treatment barriers in rural settings while evaluating the efficacy of radiation therapy for various forms of cancer.

Data Collection

It was data retrieval from our oncology centre patient records, which captured large variables such as patient demographics, cancer type, treatment procedures, and outcomes. There were 1,240 registered cancer patients in the year, and 756 patients were counselled for radiation therapy. The overall number of patients who were treated with radiation therapy was 570, of which 390 patients were treated with radiation for a radical purpose and 180 patients for a palliative purpose. Data were also collected on patients unable to undergo radiation therapy (186 in total), the reasons being refusal due to cost (e.g., accommodation and travel costs), fear of side effects, extensive distances travelled, and a perception that preceding therapies (surgery or chemotherapy) had been sufficient. Data on secondary cancers (bone metastases, brain metastases, etc.) and results from palliative radiation therapy were also recorded. These files provided a comprehensive dataset to assess the success of treatment, patient results, and socio-economic impacts of radiation therapy.

Patient Demographics

The patient sample consisted of 1,240 cancer patients registered within a year with a nearly equal gender distribution (598 males and 642 females). The most frequent cancers in the sample were breast cancer (255 patients), lung cancer (228 patients), and head and neck cancers (196 patients). The other common cancers included cervical cancer (71 patients), rectal cancer (63 patients), prostate cancer (36 patients), and bladder cancer (52 patients), besides other secondary cancers such as brain and bone metastases. Demographic representation of the cohort was also denoted as showing that the majority of the patients were of the rural, at large, often distant locality from radiation centres, and thus had distant travel to reach the centres. These figures are crucial in establishing the socio-economic factors of choice of treatments and the influence of rural residency on access to care and patient outcomes.

Treatment Modalities

Treatment modalities examined in this study included two general types: radical and palliative radiation therapy. Radical radiation therapy was used with curative intent for the management of local cancers, most frequently as a primary treatment or in combination with surgery or chemotherapy. Radical intent radiation was given in the cohort by 390 patients, for primary tumors with curative intent. Palliative radiation, given to 180 patients to relieve symptoms and enhance the quality of life in patients with far-advanced or metastatic disease, was used. Palliative radiation was especially crucial in the cases of secondary cancers, such as bone metastases in 84 patients, brain metastases in 58 patients, and other sites of metastases in 38 patients. The radical or palliative approach was decided based on factors of cancer stage, overall prognosis, and patient preference, with the palliative approach being indicated in managing metastatic cases.

Measurement Parameters

Key parameters that were studied to evaluate radiation therapy outcomes in rural Indian cancer patients included survival rates, side effects, cost-benefit ratio, and wage loss. Survival rates were compared between patients receiving radical and palliative radiation, with particular emphasis on completion of treatment and recurrence. Side effects, which were acute or chronic, were monitored, with particular interest in fatigue, skin reactions, and pain. A cost-benefit analysis balances treatment cost, travel, accommodation, and wage loss against the survival and quality of life improvement benefits. Loss of wages through time off for treatment was also recorded to assess the socio-economic effect.

Ethical Considerations

The study was performed in compliance with the Declaration of Helsinki (2013) and ICMJE ethics. Permission was received from the Institutional Ethics Committee of the cancer center. Since it was a retrospective study, written informed consent was not required. Privacy and confidentiality of patients were maintained in strict compliance, with all information anonymized and processed according to institutional and national guidelines.

Conflict of Interest: The authors have no conflicts of interest.

Funding Statement: No external funding was received for this study.

Results

Comparison Between Palliative Patients and Treatment Refusal:

Out of 366 patients, 180 were palliative and 186 were refusals. The association of the refusal with the aspects of financial constraint and fear of side effects was found to be high, reaching up to 57% and 32.3 % respectively, compared to the palliative patients, which were 42 % and 18% respectively. Both cost and side effects were significant in Chi-square tests ($p = 0.03$ and $p = 0.01$, respectively). Regarding the perceived adequate prior treatment, no difference was identified. Due to these findings, it is possible to assume that economic and psychosocial considerations play a significant role in choices about treatment, and financial concerns are the most frequent source of these. Table 1 shows the prevalence of financial constraints, concerns about side effects, and perceptions about the previously received treatment, where financial constraints and concerns about side effects differ significantly between the palliative and refusal groups.

Table 1: Comparison of Key Barriers Between Palliative Patients and Treatment Refusal Cases

Factor	Palliative (%)	Refusal (%)	p-value
Financial Constraints	42	57	0.03
Fear of Side Effects	18	32.3	0.01
Adequate Prior Treatment	10	10.7	0.88

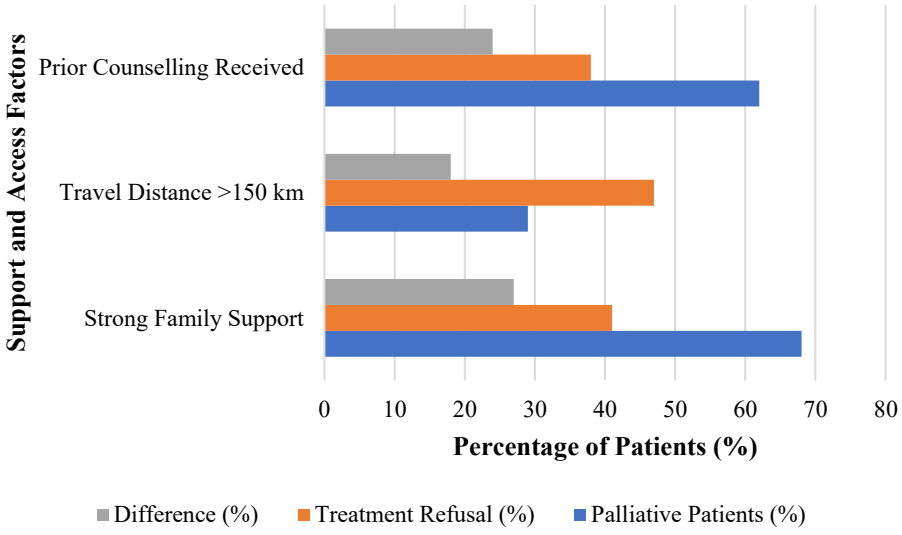

Figure 1: Palliative Patients vs. Treatment Refusal by Support and Access Factors

Figure 1 shows that 68% of palliative patients reported high family support compared to 41% of refusals, travel more than 150 km impacted 29% of palliative patients compared to 47% of refusals, and 62% had received prior counselling compared to 38%, respectively.

Cost and Side Effect Concerns in Treatment Refusal

Multivariate analysis demonstrated that both financial issues and fear of adverse effects were important predictors of treatment refusal. The patients having both concerns showed the highest rate of refusal (66%), which is almost three and a half times more likely than those with no concerns to refuse getting treated. Cost-only and side effect-only concerns led to refusal rates of 39% and 29% respectively, which is considerably higher compared to the 13% refusal rate that patients without these barriers have. These results indicate that there is a need to offer specific financial support and better counselling to patients in regards to treatment refusal. Table 2 shows that the majority of patients are associated with the refusal to take treatment due to the cost concerns, side effect concerns, and more than one of these factors, with the highest refusal rate (66%) and odds ratio (3.5) compared to the refusal rate of 13% and an odds ratio of 1.0 in patients lacking either of the mentioned concerns.

Table 2: Impact of Cost and Side Effect Concerns on Treatment Refusal

Concern Category	Refusal Rate (%)	Odds Ratio (95% CI)
No Cost / No Side Effects	13	1.0 (—)
Cost Only	39	2.7 (1.9–3.9)
Side Effects Only	29	2.1 (1.3–3.3)
Both Cost & Side Effects	66	3.5 (2.2–5.7)

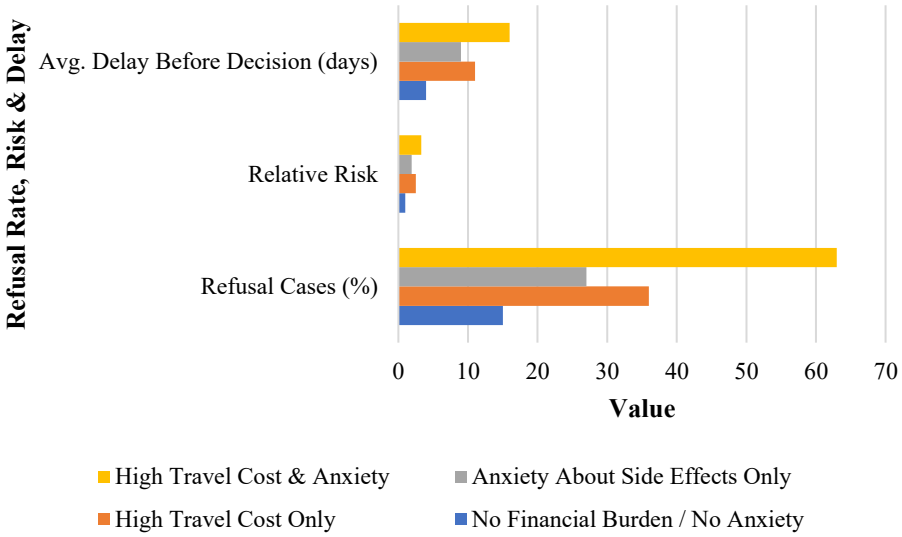

Figure 2: Alternative Factors Influencing Treatment Refusal

Figure 2 shows refusal rates between 15% and 63%, most significant with the combined cost of travel and anxiety, a relative risk up to 3.3, and delays in decisions of 4–16 days.

Sex and Treatment Acceptance

Among 756 patients who were recommended radiation, 326 women (81.2 %) opted to take treatment as compared to 248 men (69.9 %), p = 0.004. Greater acceptance in women could be associated with the prevalence of breast and cervical cancers, which have already established the benefit of radical radiation. This difference in gender highlights possible sociocultural and condition-profile variables in compliance with treatment. The presence of barriers may affect the status of male patients adversely and thus lead to an increase in uptake rates. Logistic regression analysis has revealed that the odds of admitting treatment in female patients were 1.78 times higher than those of male patients (95% CI: 1.30–2.43, p = 0.004) after age and type of cancer had been considered. Figure 3 shows that acceptance of the treatment was also significantly higher in females (81.2%) than in males (69.9%),

with an accompanying significance of p = 0.004, which means gender-based differences existed in terms of adopting the treatment.

Table 3: Gender-Based Comparison of Radiation Therapy Acceptance Rates

Gender	Advised (n)	Accepted (n)	Acceptance (%)	p-value
Male	355	248	69.9	0.004
Female	401	326	81.2	—

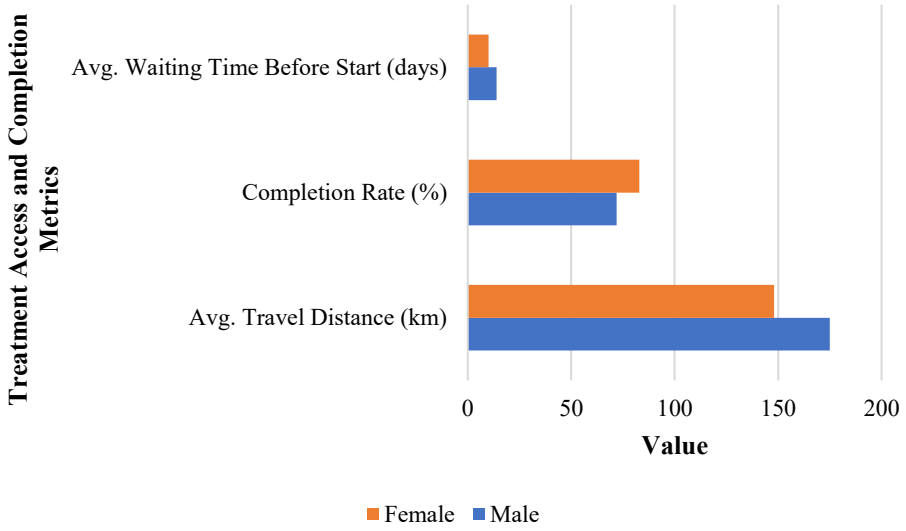

Figure 3: Gender Differences in Travel, Completion, and Waiting Time for Radiation Therapy

Figure 3 shows that females experienced shorter travel distances (148 km vs. 175 km), improved completion rates (83% vs. 72%), and lower waiting times before treatment initiation (10 vs. 14 days) than males.

Overall Survival: Radical vs. Palliative Therapy

Survival analysis revealed a median survival of 48 months for radical radiation and 18 months for palliative therapy. The difference was significant (log-rank $p < 0.001$) with a hazard ratio of 2.15 (95% CI: 1.78–2.59) for death in the palliative group. Radical therapy generally yielded superior long-term results, emphasizing the importance of early treatment. Table 4 shows that radical therapy had a median survival of 48 months, while that for palliative therapy was 18 months. The hazard ratio of 2.15 represents greater than twice the mortality risk in palliative patients, and this difference is statistically significant at $p < 0.001$.

Table 4: Median Survival and Mortality Risk by Treatment Type

Treatment Type	Median Survival (months)	Hazard Ratio	95% CI	p-value
Radical	48	1.00	—	—
Palliative	18	2.15	1.78–2.59	<0.001

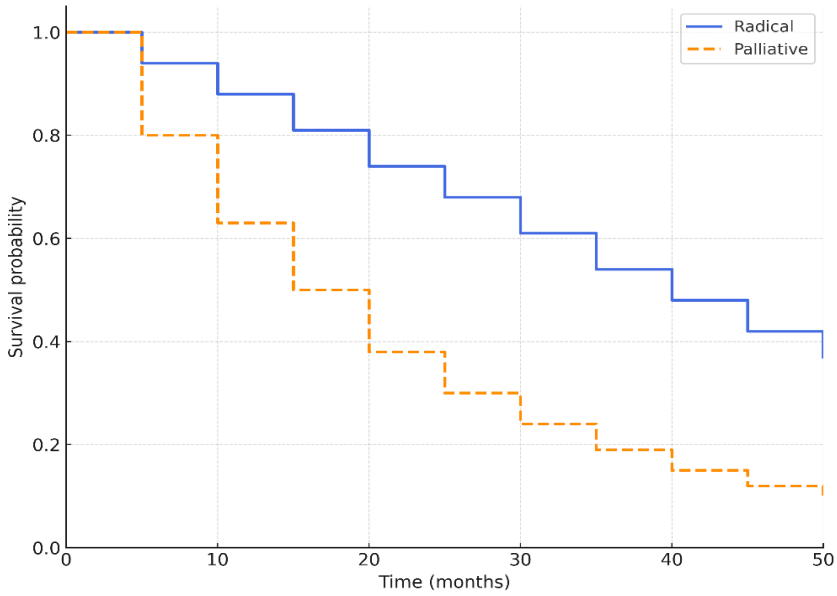

Figure 4: Kaplan–Meier Survival Curves Comparing Radical and Palliative Radiation Therapy

Figure 4 provides the Kaplan–Meier survival curves for radical and palliative radiation therapy recipients. The curves illustrate a highly significant longer survival period in the radical therapy group (log-rank $p < 0.001$).

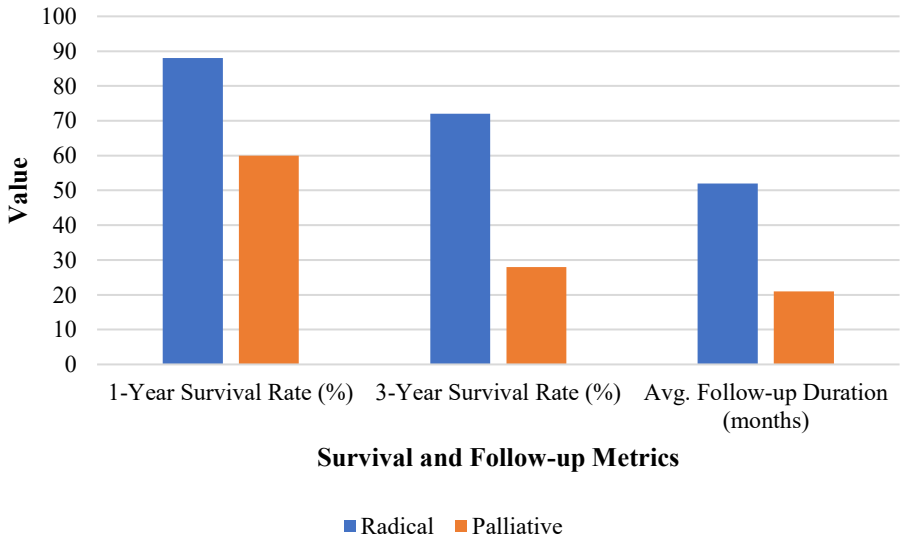

Figure 5: Short- and Medium-Term Survival and Follow-up by Treatment Type

Figure 5 shows that the survival was greater for radical therapy at both 1 year (88%) and 3 years (72%) compared to palliative therapy (60% and 28%). Follow-up was also longer for radical therapy on average (52 months) than for palliative therapy (21 months) [with maximum follow-up restricted to 50 months in the analysis], suggesting ongoing benefit and surveillance.

Comparative Side Effect Profile

Radical radiation patients had more side effects—fatigue (50%), skin erythema (45%), and pain (30%)—than palliative patients (20%, 15%, and 10%, respectively). The differences were all significant at $p < 0.001$. These results infer that radical therapy, although beneficial for survival, is accompanied by increased toxicity, necessitating strong symptom management protocols. Relative risk analysis indicated that radical therapy patients were 2.5 times more likely to report fatigue, 3.0 times more likely to report skin reactions, and 3.2 times more likely to report pain than palliative therapy patients (all $p < 0.001$). Table 5 shows greater frequencies of fatigue, skin reactions, pain, and nausea/dysphagia for radical therapy than for palliative therapy. All comparisons were statistically significant ($p < 0.001$). Chronic organ damage was seen only in radical therapy.

Table 5: Comparison of Common Side Effects Between Radical and Palliative Radiation Therapy

Side Effect	Radical (%)	Palliative (%)	p-value
Fatigue	50	20	<0.001
Skin Reactions	45	15	<0.001
Pain	30	10	<0.001
Nausea/Dysphagia	25	5	<0.001
Chronic Organ Damage	10	N/A	—

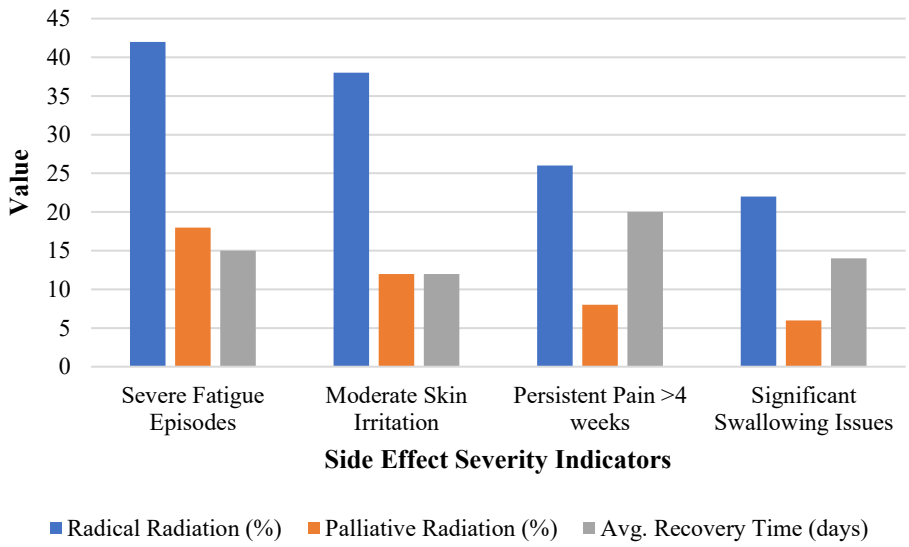

Figure 6: Severity and Recovery of Side Effects by Treatment Type

Figure 6 shows that radical radiation relates to increased frequencies of severe fatigue (42%), moderate skin irritation (38%), pain lasting more than 4 weeks (26%), and significant swallowing difficulty (22%) than does palliative therapy. Recovery periods took anywhere from 12 to 20 days, with the worst delays being in the case of persistent pain.

Discussion

The results of this study indicate a significant difference in the uptake and outcome of treatment between radical and palliative radiotherapy in rural Indian cancer patients. Median survival was significantly higher in the radical therapy arm (48 months) than in the palliative arm (18 months), with over twice the risk of mortality in palliative patients (HR = 2.15, $p < 0.001$). Radical radiotherapy was also associated with greater 1-year (88% vs. 60%) and 3-year (72% vs. 28%) survival rates, reflecting extended clinical benefit. The survival benefit was associated with increased rates of toxicity—fatigue (50% vs. 20%), skin reactions (45% vs. 15%), and pain (30% vs. 10%), as in Table 5, emphasizing the importance of active side-effect management. Socioeconomic considerations were

the main reason for treatment refusal, with 57% of refusals due to financial issues and 32.3% due to side effects, versus 42% and 18%, respectively, among palliative patients (Table 1). Differences between genders also emerged, with females having greater acceptance (81.2% vs. 69.9%), shorter travel distances, and greater completion rates.

These findings suggest that better availability of radical radiation therapy in rural areas could significantly boost survival rates. However, this will only be possible on the condition of well-developed support networks in terms of finance, decentralisation of treatment units, and organised side-effect amelioration schemes. Refusal rates can be reduced by targeted counselling in an attempt to deal with the fear of side effects, especially in economically vulnerable populations. The differences between genders imply that it is necessary to explore male-patient-specific barriers and design interventions to address them. Enhancing adherence and completion of treatment by incorporating patient education, involving caregivers, and providing travel support in the rural oncology programs is desirable. Palliative patients, even knowing radiation will not cure them fully but can provide some symptomatic relief, received radiation treatment by getting more family support, less travel distance, and better counselling in comparison to the treatment refusal group.

At other settings, there is consistent evidence that early and dose-intensive radiation therapy increases long-term survival of cancer patients even in a resource-scarce setting [22]. As observed in this case, as with other reported patterns, refusal rate can be correlated with cost, and fear of adverse effects, and survival advantages of radical therapy as compared to palliative therapy are obvious even across types of diseases [23]. A theme common to all the sessions is the added toxicity burden that accompanies radical therapy; the need to provide supportive treatments in conjunction with curative treatment is universal [24]. Differences are also reported in gender-based uptake in other locations, which can be attributed to socio-cultural and disease-profile effects [25].

The plans need to work on maximising local radiotherapy facilities to reduce travel burden, subsidised treatment plans should be developed to overcome refusal due to costs, and standard counselling systems must be put in place that increase the patient awareness of trade-offs between benefits and risks. It might also be possible to facilitate such adherence by incorporating tele-oncology follow-up, especially among patients who do not live in major cities. Simultaneously, it will be necessary to invest in employee schooling and supplementary processes to treat side effects, to provide maximum benefit of radical treatment, and to reduce the disadvantages thereof.

Conclusion

Radiation oncology contributes significantly to the overall treatment of cancer and has curative and palliative effects depending on the stage of the disease, health status of the patient, and accessibility of radiation treatment. The current investigation shows that radical radiation therapy has important survival benefits compared to a palliative treatment approach in rural Indian cancer patients, with a median survival of 48 months as opposed to 18 months. The long-term efficacy of radical treatment is supported by the survival probabilities at 1, 3, and 5 years, although treated with an upper risk of reliance toxicity. Financial constraints, the perceived side effects, and logistics became key factors in the rejection or acceptance of treatment, as cost limitations alone led to more than half of the rejection of treatment. There was also a gender gap, with female patients showing better acceptance and completion rates, which might be related to the distance to the place of treatment and more compliance with medical instructions. The findings contribute to the importance of systematic interventions, including decentralisation of radiotherapy centres, formal counselling of patients, improved financial provisions, and functional plans of supportive care to fill the toxicity loop. This is necessary to maximise treatment outcomes, especially in resource-poor settings where late presentation and economic adversity are common. Finally, an accessible delivery of radical radiation therapy, with an optimal policy and infrastructure, could address the survival and the quality of life of cancer patients in rural areas, as well as diminish the inequality in delivering oncological care.

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