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Research Article

"Incidence of Radiation-Induced Cystitis and Proctitis on MRI among Post-Radiotherapy Patients at BPKMCH"

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Abstract

Objective: This study aims to show the Incidence of Radiation-Induced Proctitis and Cystitis on MRI among Post-Radiotherapy Patients at B.P Koirala Memorial Cancer Hospital.

Materials and Methods: A total of 139 cervical cancer patients who received radiation therapy at B.P Koirala Memorial Cancer Hospital from February 2025 - May 2025 who met the inclusion criteria are included in this study. Factors assessed included age, history of radical hysterectomy surgery and duration of radiation. Moreover, different cystitis and Proctitis features are noted for the analysis. DWI/ADC can also use distinguish active inflammation (restricted diffusion) from chronic fibrosis (low signal, no restriction), and wall thickness is measured using software tools.

Results: A total of 139 cervical cancer patients who received radiation therapy at BPKMCH during the study period were included in the analysis. The patients' ages ranged from 25 to 78 years, with a mean age of 52.17 ± 11.73years. Age-wise distribution showed the highest number of patients in the 50-60 years age group. Radiation-induced cystitis occurred in 18 patients, corresponding to 13% of the cohort. Among these, mean thickness was 5.11 mm while minimum and maximum was 4 mm and 6 mm respectively with S.D of 0.75. Radiation-induced Proctitis was observed in 43 patients, representing 31% of the study population. Among these, mean thickness was 7.55 mm while minimum and maximum was 5 mm and 11 mm respectively with S.D of 1.42.

Conclusion: Radiation-induced Proctitis and cystitis remain significant complications of pelvic radiotherapy for cervical cancer. MRI plays an essential role in early detection, severity assessment, and differentiation from other pathologies, supporting timely intervention and improved patient care.

Keywords: Radiation; Cystitis; Proctitis; MRI; BPKMCH

Introduction

Cystitis and proctitis are defined as inflammation of bladder and rectum respectively. Etiologies of cystitis can be infective and non-infective (sterile). Cause of sterile cystitis can be radiation, chemical, mechanical and interstitial. Non-infective cystitis is usually more severe and can cause intense pain, irritative voiding symptoms and hematuria. Hemorrhagic cystitis is the most severe clinical manifestation of radiation and chemical cystitis[1]. Radiotherapy is one of the most common treatment modalities used for treatment of carcinoma cervix, rectum and prostate. Radiation proctitis and cystitis are major complications following radiotherapy. MRI is a valuable imaging modality for assessing and characterizing radiation-induced proctitis and cystitis, particularly for evaluating the extent and severity of tissue damage. It can help differentiate between early and late changes, assess complications like fistulas, and potentially differentiate radiation-related changes from tumor recurrence.

Types of radiotherapy

RT to the pelvis is an important component of the treatment regimens available for pelvic cancers. It can be administered as adjuvant or neoadjuvant RT. Higher doses of radiation may be required for treating rectal cancers as they usually show resistance to low-dose RT.

The modes through which RT can be delivered include external beam radiation and brachytherapy.

- **External beam radiation** [2]**:** It is administered via an external photon generator, with various sources, including gamma rays, approach. External beam radiation usually results in significant exposure to the surrounding tissues. However, newer methods of external beam radiation, such as three-dimensional conformal radiation therapy and intensity-modulated radiation therapy, allow for the utilization of higher doses of radiation to targeted tissues with significantly less exposure to normal tissues. This leads to significantly less radiation damage to normal tissues.
- **Brachytherapy:** It consists of two methods of delivering radiation in a highly site-specific manner, intending to minimize damage to the surrounding tissues. The most common method is implanting radioactive pellets, usually iodine 125 or palladium 103, into targeted tissues, with a gradual release over time. An alternative method involves the use of hollow catheters progressively filled with increasing amounts of radioactive pellets over time. Compared with external beam radiation, brachytherapy has shown decreased rates of both acute (6% vs. 43%) and chronic (2% vs. 21%) complications. However, as with any treatment modality, there are side effects and complications. With the use of higher doses of radiation for the treatment of cancers, RP is one of the most common complications.17 Physicians are beginning to encounter more cases of RP due to the increasing number of cancer survivors and the fact that most of these patients have undergone RT as a part of their treatment regimens.

On MRI

- **Radiation-induced proctitis** typically shows circumferential rectal wall thickening, hypointense signal on T1, variable T2 signal (depending on edema vs fibrosis), mucosal enhancement after contrast, and reduced rectal compliance. Chronic cases may demonstrate fibrosis with low T2 signal intensity and luminal narrowing.
- **Radiation-induced cystitis** appears as diffuse or focal bladder wall thickening, decreased bladder capacity, and irregular mucosal enhancement. Chronic fibrosis results in a low T2 signal bladder wall with loss of distensibility, sometimes associated with hemorrhagic changes or calcification.

MRI thus provides a non-invasive method to distinguish radiation-related changes from tumor recurrence, guide clinical management, and monitor progression over time.

Grading

Based on the severity of the symptoms, radiation cystitis and proctitis has been classified into a graded system from grade 0-4 by RTOG (Radiation Therapy Oncology Group) and EORTC (European Organization for Research and Treatment of Cancer) where grade 0 stands for no change from baseline while grade 4 is the most severe grade or fatal complication. Radiation induced hemorrhagic cystitis is a potentially life-threatening complication with an estimated incidence of 2-3% [3].

Objectives

This study aims to show the Incidence of Radiation-Induced Proctitis and Cystitis on MRI among Post-Radiotherapy Patients at B.P Koirala Memorial Cancer Hospital.

Materials and Methods

This was a descriptive analytic study with analytical work on 139 cervical cancer patients who received radiation therapy at B.P Koirala Memorial Cancer Hospital from February 2025 - May 2025 who met the inclusion criteria. The inclusion criteria included being diagnosed with cervical cancer based on histopathological examination and internal examination, having been diagnosed as a patient with cervical cancer based on vaginal touch examination, having completed 25 times external rays and three times inner rays or according to the full radiation dose (after complete radiation). The exclusion criteria were cervical cancer patients who did not receive radiation therapy, cervical cancer patients who received radiation therapy but not complete, patients who were not examined at the time of definitive therapy, patients who died, and patients with incomplete data.

Factors assessed included age, history of radical hysterectomy surgery and duration of radiation.

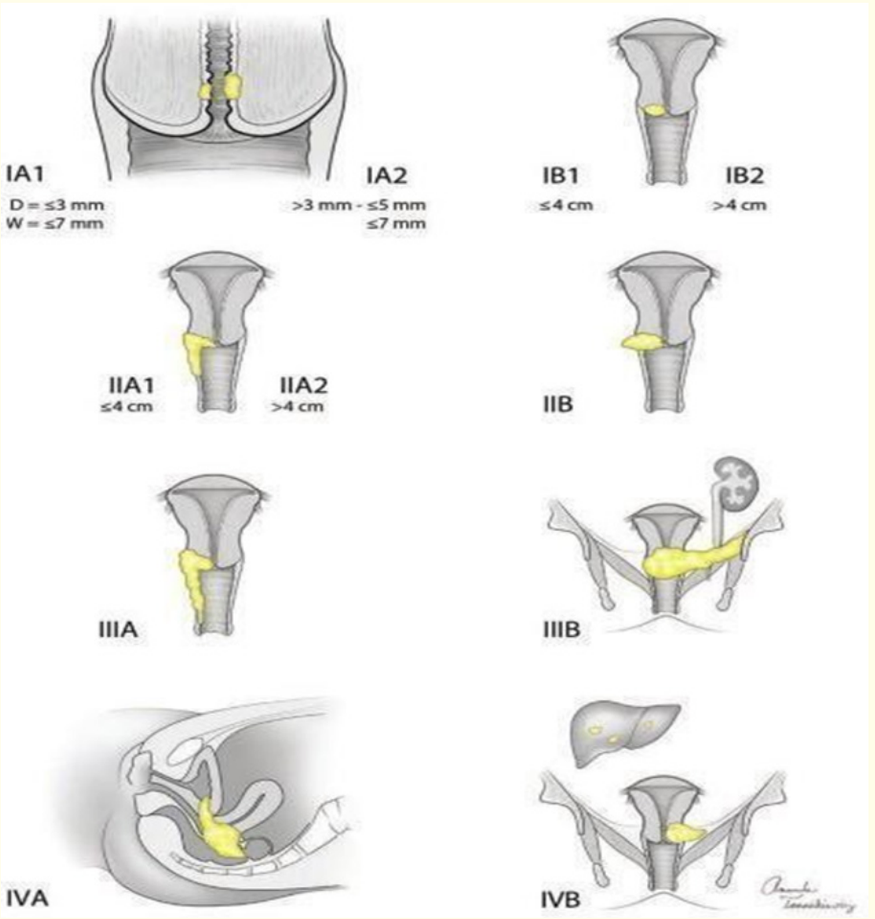

Figure a: Cervical cancer staging based on FIGO 2018.

Cystitis and Proctitis is assed as follows

Radiation-Induced Cystitis (Bladder)

Radiation-Induced Proctitis (Rectum)

Feature	Acute Phase	Chronic Phase
Wall thickness	Diffuse or focal thickening	Persistent thickening, irregular contour
T2-weighted signal	Hyperintense (edema)	Hypointense (fibrosis)
T1-weighted signal	Iso- to slightly hypointense	Iso- to hypointense
Contrast enhancement	Mucosal/submucosal enhancement	Reduced enhancement in fibrotic areas
Bladder capacity	capacity Usually normal or mildly	Significantly reduced reduced (loss of compliance)
Other findings	Hemorrhage, edema	Fibrosis, calcifications, hemorrhagic foci

Table a

Feature	Acute Phase	Chronic Phase
Wall thickness	Diffuse or circumferential thickening	Persistent thickening, may lead to stenosis
T2-weighted signal	Hyperintense (edema and inflammation	Hypointense (fibrosis)
T1-weighted signal	Iso- to slightly hypointense	Iso- to hypointense
Contrast enhancement	Mucosal/submucosal enhancement	Reduced enhancement in fibrotic areas
Luminal changes	Usually preserved	Narrowing, rigidity
Other findings	Edema, mild perirectal fat stranding	Occasionally hemorrhage, Fibrosis, strictures, fistulas

Table b

DWI/ADC can also help distinguish active inflammation (restricted diffusion) from chronic fibrosis (low signal, no restriction), and wall thickness is measured using software tools.

Results

A total of 139 cervical cancer patients who received radiation therapy at BPKMCH during the study period were included in the analysis. The patients' ages ranged from 25 to 78 years**,** with a mean age of 52.17 ± 11.73years**.** Age-wise distribution showed the highest number of patients in the 50-60 years age group.

Incidence of Radiation-Induced Cystitis

Radiation-induced cystitis occurred in 18 patients, corresponding to 13% of the cohort. Among these, mean thickness was 5.11 mm while minimum and maximum was 4 mm and 6 mm respectively with S.D of 0.75.

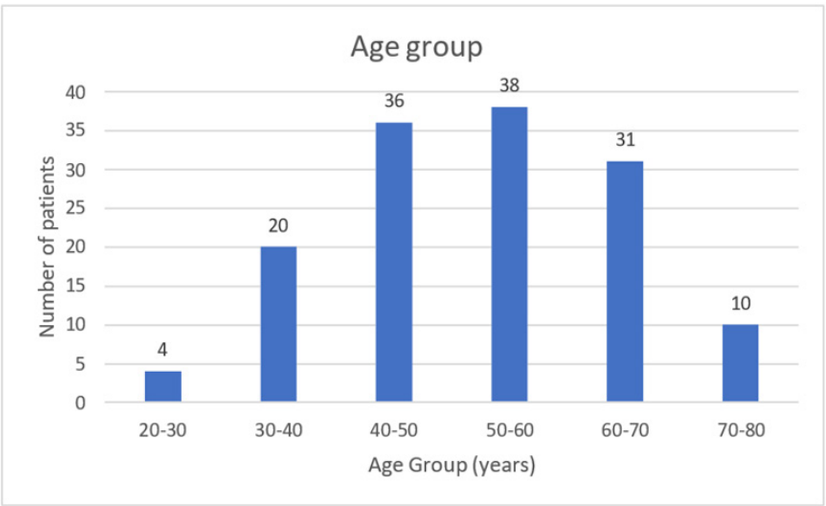

Figure b: Showing Age wise distribution.

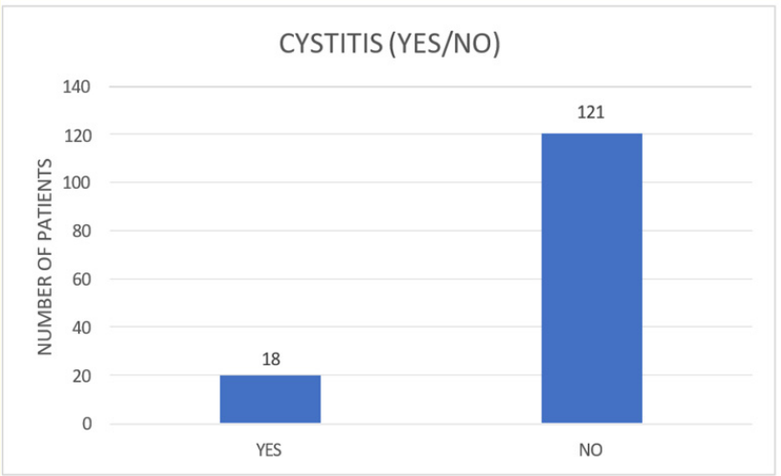

Figure c

Mean Thickness (mm)	Minimum Thickness(mm)	Maximum Thickness (mm)	S.D
5.11	4	6	0.75

Table c

Cystitis thickness, (N=18)

MRI features included bladder wall thickening, mucosal enhancement, submucosal edema, and, in severe cases, hemorrhagic spots or ulceration.

Incidence of radiation-induced proctitis

Radiation-induced proctitis was observed in 43 patients, representing 31% of the study population. Among these, mean thickness was 7.55 mm while minimum and maximum was 5 mm and 11 mm respectively with
S.D of 1.42.

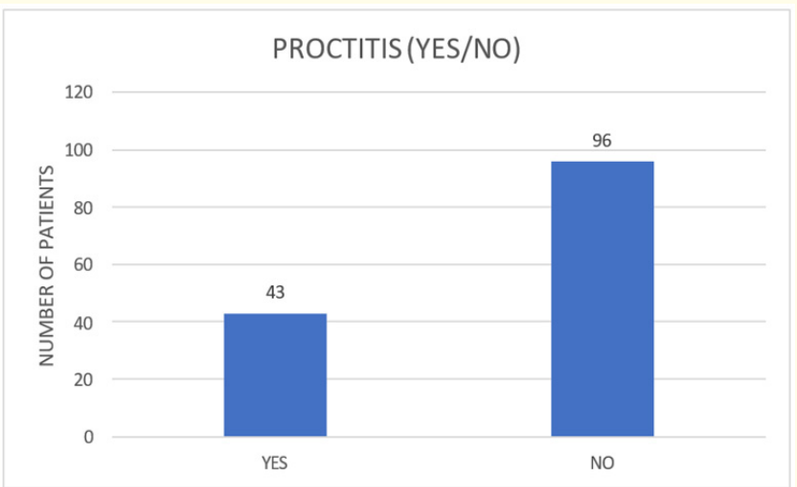

Figure d

Mean Thickness (mm)	Minimum Thickness(mm)	Maximum Thickness (mm)	S.D
7.55	5	11	1.42

Table d

Proctitis thickness (N= 43)

MRI findings demonstrated typical features of radiation proctitis, including rectal wall thickening, mucosal hyperenhancement, submucosal edema, and occasional ulcerations.

Different findings were observed among study population along with cystitis and proctitis.

Correlation with age

Statistical analysis is done with the Chi-square test with 95% confidence interval and significance level of 0.05. Result shows there is no statistically significant correlation between age and the incidence of radiation-induced Proctitis ($p = 0.87$). Similarly, no statistically significant correlation was found between age and the incidence of cystitis ($p = 0.145$).

Finding	Number of Patients
GIANT NABOTHIAN CYST	2
Hydrometra	2
Residual disease	2
Endometrial collection	6
Recurrence	6

Table e

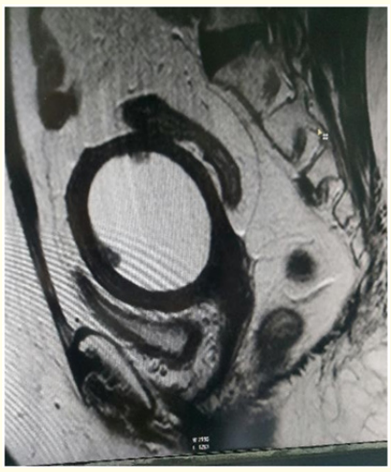

Figure e

Figure f

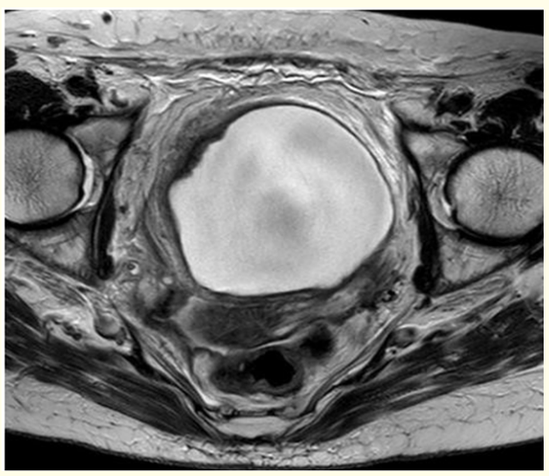

Figure g: Showing Cystitis.

Discussion

Radiation therapy is a mainstay in the treatment of cervical cancer, but its use is associated with unavoidable damage to surrounding normal tissues, particularly the rectum and bladder. In this study, we evaluated the incidence and MRI characteristics of radiation-induced proctitis and cystitis in cervical cancer patients at BPKMCH.

There are 139 cervical cancer patients who received radiation therapy at BPKMCH are included in this study. Among them ages ranged from 25 to 78 years**,** with a mean age of 52.17 ± 11.73years**.** Age-wise distribution showed the highest number of patients in the 50-60 years age group i.e. 38 patients. Similarly there are 4 patients in 20-30 years, 20 patients in 30-40 years, 36 patients in 40-50 years, 31 patients in 60-70 years and 10 patients in 70-60 years. This data shows that the age group of 50-60 years female show higher number of Cervical Cancer treatment during this period but the exact conclusion cannot determine due to a smaller number of patients data.

Among study population incidence of radiation proctitis was observed in 43 patients i.e., 31% of study population while radiation cystitis was observed in 18 patients i.e., 13 % of study poulation. While study conducted by Katsuhiro Makino., *et al.* (2022) [8] showed the incidence of radiation cystitis was 16.2%. Similarly, study conducted by D. Afonso-João (2018) [9] showed at 5 years of follow-up, cumulative incidence of overall and severe radiation cystitis was 9.1 and 1.6%, respectively. Moreover, study by Yang., *et al*. [1] (2012), 1518 women who received radiotherapy for the treatment of cervical carcinoma were retrospectively reviewed and 10.61% and 6.20% patients were diagnosed with radiation proctitis and radiation cystitis respectively. In addition to this, a study conducted by Renata Silva Aragão., *et al.* (2025) [9] on Evaluation of chronic radiation proctitis in patients with cervical cancer treated with pelvic radiotherapy shows the median patient age was 48 years , and 87 (38.5%) experienced Radiation proctitis symptoms, represented by rectal bleeding; of these, 59 underwent colonoscopy, confirming Radiation Proctitis in 58 (98.3%). Accordingly, of the 226 females analyzed, 58 (25.7%) had a confirmed diagnosis of Radiation proctitis.

Variations in incidence are often due to differences in radiation techniques, total dose, fractionation, and patient-related factors such as age, comorbidities, and concurrent chemotherapy.

MRI findings in affected patients revealed characteristic features of tissue injury, including rectal or bladder wall thickening, mucosal hyperenhancement, submucosal edema, and, in severe cases, ulceration or hemorrhage. These findings align with prior studies and demonstrate the value of MRI in accurately detecting radiation-induced changes, differentiating them from tumor recurrence or other inflammatory conditions, and guiding clinical management. Wall thickening was the primary features and in case of cystitis mean thickness was 5.11 mm while minimum and maximum was 4 mm and 6 mm respectively with S.D of 0.75. Also, in case of proctitis, mean thickness was 7.55 mm while minimum and maximum was 5 mm and 11 mm respectively with S.D of 1.42.

Statistical analysis is done with the Chi-square test with 95% confidence interval and significance level of 0.05. Result shows there is no statistically significant correlation between age and the incidence of radiation-induced Proctitis ($p = 0.87$). Similarly, no statistically significant correlation was found between age and the incidence of cystitis ($p = 0.145$). Although older patients showed a trend toward higher incidence, statistical analysis did not reveal a significant correlation between age and occurrence of either proctitis or cystitis. This finding was similar to the study conducted by D. Afonso-João (2018) [9] that also showed no association was found between the incidence of radiation cystitis and age. This suggests that factors such as radiation dose distribution, individual radiosensitivity, and concomitant therapies may play a more critical role than age alone in determining susceptibility.

Other different MR finding were observed during the study like Giant Nabothian cyst in 2 patients, hydrometria in 2 patients, Residual disease in 2 patients, Endometrial collection in 6 patients and Recurrence in 6 patients.

Clinically, the early identification of radiation-induced proctitis and cystitis is crucial. Mild cases may respond to conservative management including dietary modifications, anti-inflammatory therapy, and symptom control, while severe cases may require endoscopic or surgical interventions. MRI provides a non-invasive and reliable method to assess severity and monitor treatment response.

Limitation

The study is limited by its single-center design and relatively small sample size, which may restrict the generalizability of the results. Additionally, the correlation between MRI findings and patient-reported symptoms was not extensively analyzed, which could have provided deeper insight into the functional impact of radiation toxicity. Future studies with larger, multicenter cohorts and longitudinal follow-up are warranted to better understand risk factors and develop preventive strategies.

Conclusion

In conclusion, radiation-induced proctitis and cystitis remain significant complications of pelvic radiotherapy for cervical cancer. MRI plays an essential role in early detection, severity assessment, and differentiation from other pathologies, supporting timely intervention and improved patient care.

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