International Journal of Clinical Oncology and Cancer Research
2024, Vol. 9, No. 4, pp. 57-62
https://doi.org/10.11648/j.ijcocr.20240904.12

SciencePG
Science Publishing Group

Research Article

Comparative Study to Evaluate Irradiated Small Bowel Volume with or Without Using Belly Board During Treating Pelvic Malignancy in 3DCRT Technique

Shuvra Debnath[1, *], Muhammad Abdullah-Al-Noman[1], Mohammed Shaiful Hassan Shameem[1], Swapan Kumar Bandyopadhayaa[2], Shafayat Muhammed[3], Nihar Ranjon Das[4], Md. Golam Zel Asmaul Husna[1], Tasneem Hossain[1], Saiful Alam[1], Tasnim Mahmud[5]

[1]Department of Radiation Oncology, National Institute of Cancer Research & Hospital (NICRH), Dhaka, Bangladesh
[2]Ex- Director, National Institute of Cancer Research & Hospital (NICRH), Dhaka, Bangladesh
[3] Department of Surgery, Dhaka Medical College, Dhaka, Bangladesh
[4]Department of Medicine, Suhrawardy Medical College, Dhaka, Bangladesh
[5]Department of Public Health, North South University, Dhaka, Bangladesh

Abstract

Gastrointestinal (GI) toxicity is the most frequently encountered complication of pelvic radiotherapy with clinically significant acute and late toxicity occurring in up to 60% and 20% of patients, respectively. The current study was conducted to assess and compare irradiated small bowel volume and dose between prone position using belly board and supine position without belly board in pelvic radiotherapy. Methods: It was a quasi-experimental study conducted at the department of Radiation Oncology of NICRH. Sixty patients of rectal and cervical malignancy were included in the study. They were enrolled in either arm A or arm B to receive radiotherapy to pelvis in supine position or prone position with belly board, respectively by 3DCRT technique. Results: There were no statistically significant differences in distributions of the patients across the two arms regarding age and other various demographic data, abdominal girth etc. Irradiated volume was significantly low in arm-B ($5189cm^3$ vs. $3485cm^3$, *p-value*<0.001). Small bowel volume which received 45Gy was also significantly low in arm-B ($351cm^3$ vs. $191cm^3$, *p-value*<0.001). Radiation dose to $195cm^3$ of small bowel volume was 53Gy vs. 36Gy in arm-A and arm-B respectively (*p-value*<0.001). Conclusion: Using belly board in prone position is comfortable, inexpensive, highly reproducible, and permits maximal bowel displacement from standard pelvic radiotherapy fields.

Keywords

Belly Board, Irradiated Bowel Volume, Malignancy, Pelvic

[*]Corresponding author: dr.shuvra03@gmail.com (Shuvra Debnath)

Received: 13 November 2024; **Accepted:** 26 November 2024; **Published:** 13 December 2024

1. Introduction

Radiation therapy to the pelvis is commonly used to treat patients with lower gastrointestinal tract cancers such as rectal cancer, cervical cancer and uterine cancer etc [1]. Pre or postoperative radiotherapy alone or in combination with chemotherapy plays a significant role in the treatment of pelvic malignancy. For pelvic irradiation the small bowel is the most important dose-limiting structure. Therefore, the acute and chronic enteric toxicity is a widely known radiation complication and mainly depends on the volume of irradiated small bowel [2]. However, the successes achieved with this treatment come at a risk of small bowel complications. These are among the most important toxicities of pelvic radiation and can result in significant long-term morbidity [3]. Frequently, large volumes of small bowel have to be included in the radiation ports to treat the tumor and regional lymph nodes adequately. Both the radiation dose to the small bowel and the volume of small bowel included in the radiation field are factors known to influence the risk of complications. So, sparing of small bowel can improve the quality of life of patient [4]. Numerous surgical techniques have been used to reduce the small bowel volume within the radiation field. These procedures demonstrate a significant morbidity and have variable success. In addition, these techniques are relevant only during operative intervention. Due to the mobility of the small intestine, a variety of noninvasive techniques maneuvering the small bowel out of the field have been reported. Bladder distention, Trendelenburg position, and belly board devices (BBDs) have been reported to decrease gastrointestinal morbidity in rectal carcinoma patients [5].

After radical hysterectomy and postoperative RT small bowel obstructions occur in up to 5% of patients [6]. Devices and techniques such as the BBD may position the small bowel out of the radiation field and increase the therapeutic ratio. Many investigators have evaluated the volume of small bowel irradiated in prone position using belly board and supine position. The volume of small bowel receiving radiation is significantly low when patient is positioned prone using belly board. Although this is a simple and noninvasive option for reducing small bowel toxicity, it has its own pitfalls. Treating the patient in a reproducible and comfortable position is of utmost importance. Certain patient factors like slow healing surgical scar, obesity, and osteoarthritis influence the patient positioning on belly board. Setup variations using belly board has not been studied widely [7].

Patients of cervical and rectal carcinoma will be considered in this study for radiotherapy to pelvis in two treatment position. Experience with radiotherapy to pelvis in supine position and prone position with belly board will be reviewed. In this study, an analysis of all the patients who will receive external beam radiation therapy in two treatment position mentioned above will be carried out with an aim to assess the irradiated small bowel volume and other volumetric and dosimetric data by evaluating treatment plan and dose volume histogram (DVH).

2. Methods

This Quasi-experimental study was conducted from From July 2018 to June 2019. It took place at National Institute of Cancer Research and Hospitals, Mohakhali, Dhaka, Bangladesh. Patients with histopathology report proven Rectal and cervical cancer were chosen for enrollment. After enrollment of the patients, preliminary data were collected regarding demography, history and physical examination. An interview usually lasted for 20 minutes. Sixty patients were divided into two arms, 30 patients in arm-A (control arm) and 30 patients in arm-B (experimental arm). Intervention was given according to the planned radiotherapy position, that is supine position in arm-A and prone position with belly board in arm-B. The caudal edge of the belly board was placed at the level of highest point of iliac crest for each patient of arm-B. Then CT simulation was done with adequate immobilization procedure. Every scan was done with full bladder filling protocol. CT simulation data were transferred to TPS (treatment planning system) for contouring the volumes, beam arrangement and finally volumetric and dosimetric data were collected. Data were collected for about eight months. Purposive sampling technique was used. Samples were selected through inclusion and exclusion method from the patients who are histologically proven cases of cervical carcinoma. Those who gave informed written consent were finally enrolled in the study.

Inclusion criteria

1. Histopathologically proved rectal and cervical cancer.
2. Planned to treat with radiotherapy to pelvis.

Exclusion criteria:

1. Patient's age is less than 18 years.
2. Patient's performance status is unsatisfactory (ECOG performance status: >2). Prior radiotherapy to pelvis.
3. Pregnant women.
4. Evidence of distant metastasis radiologically and clinically. Recurrent cases.
5. Patients who do not give consent to be included in the study.

After cleaning and editing, all the relevant data were compiled on a master chart. Statistical analysis of the results was obtained by SPSS for Windows (IBM SPSS Statistics for Windows, version 22.0, Armonk, NY, IBM Corp.). Categorical data were expressed as number and percentage and were compared via the Chi-squared test and Fischer's exact tests. Continuous data were expressed as mean ± SD and were compared by Student "t" test. Two tailed p-value<0.05 was considered as significant.

3. Result

Table 1 illustrated sociodemographic characteristics of respondents. Most of the female patients in both arms were housewives (60% and 63.4% in arm A and in arm B respectively). Businesses were leading profession among male patients in both arms (23.3%) followed by official jobs (10% in arm A and 3.3% in arm B). On the basis of monthly family income, most of the patients in both arms were from average class (90% in both arms). About 10% patients in arm A and 6.7% patients in arm B were from poor class. Most patients in both arms (86.7% in arm A and 90% in arm B) were literate.

Table 1. Sociodemographic characteristics of respondents.

Distribution of the patients by occupation				
Occupation	Arm A	Arm B	Fisher's Exact Test	p-value
Business	7 (23.0)	7 (23.0)		
Farmer	2 (6.7)	3 (10.0)	1.267	0.836
Official	3 (10.0)	1 (3.3)		
Others	18 (60.0)	19 (63.4)		
Distribution of the patients by economic status				
Economic status	Arm A (Control)	Arm B (Case)	Fisher's Exact Test	*p*-value
Poor	3 (10.0)	2 (6.7)		
Average	27 (90.0)	27 (90.0)	1.201	1.00
Rich	0 (0.0)	1 (3.3)		
Distribution of the patients by education				
Education	Arm A (Control)	Arm B (Case)	Fisher's Exact Test	*p*-value
Illiterate	4 (13.3)	3 (10.0)	0.162	1.00
Literate	26 (86.7)	27 (90.0)		

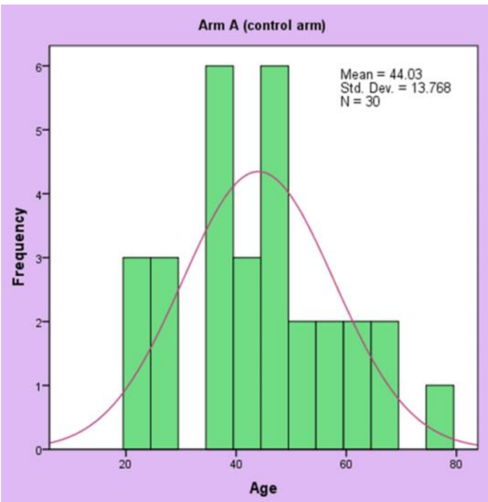

Figure 1. Age distribution of control patients (arm A).

Figure 1 showed age distribution of control patients. Mean age was 44.03 years with SD±13.77 years. Most of the patients were from 40-60 years age group.

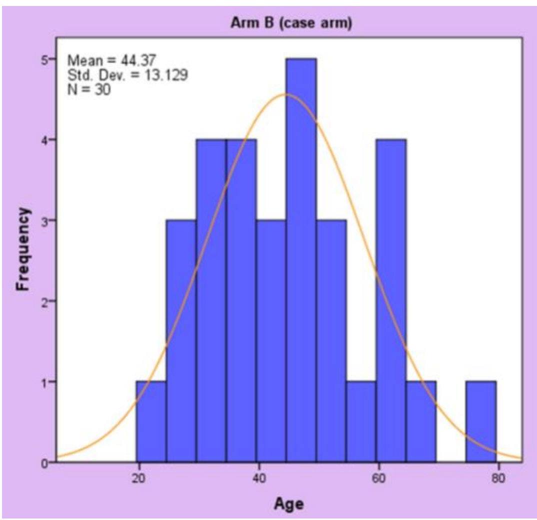

Figure 2. Age distribution of case patients (arm B).

Figure 2 illustrated age distribution of case patients. Mean age was 44.33 years with SD±13.13 years. Most of the patients were from 35-55 years age group.

Table 2 showed the comparison of abdominal girth of the patient in both arms. In Arm-A the mean abdominal girth was 37.2cm and in arm-B the mean abdominal girth was 36.7cm. However, this difference was statistically not significant (*p-value*>0.05)

Table 2. *Comparison of abdominal girth at level of highest point of iliac crest across arms (n=60).*

	Arm	Mean Volume (cm)	SD	t-value	p-value
Mean Abdominal girth	A (control)	37.2	2.5	2.01	<0.1
	B	36.7	1.9		

Table 3 shows the distribution of by the patients by type of cancer. Adenocarcinoma was leading cancer type in both arms (63.3% in arm A and 53.3% in arm B). The remaining patients were suffering from Squamous cell carcinoma. However, this difference was statistically not significant (*p-value*>0.05).

Table 3. *Distribution of the patients by histopathology.*

	Arm	Mean Volume (cm)	SD	t-value	p-value
Mean Abdominal girth	A (control)	37.2	2.5	2.01	<0.1
	B	36.7	1.9		

Irradiated small bowel volume across arms is compared in the above table (Table 4). In control patients the mean volume was 2987.07 ± 623.74 cm^3 while patients with belly board (cases) had a mean volume of 2157.18 ± 720.33 cm^3 which is statistically highly significant (*p- value*<0.001).

Table 4. *Comparison of irradiated small bowel volume across arms (n=60).*

Volume cm^3	Arm	Mean	SD	t-value	p-value
Irradiated bowel volume	A (Control)	2987.07	623.74	10.06	<0.01
	B (Case)	1687.18	334.08		

Table 5 showed comparison of mean small bowel volume which getting 45Gy radiation dose across arms. In control patients the mean volume was 351.85 ± 36.74 cm^3 while patients with belly board (cases) had a mean volume of 191.84 ± 21.08 cm^3 which is statistically highly significant (*p-value*<0.001).

Table 5. *Comparison of small bowel volume getting 45Gy across arms.*

Volume cm^3	Arm	Mean	SD	t-value	p-value
Mean small bowel volume getting 45Gy of radiation	A (Control)	351.85	36.74	7.965	<0.001
	B (Case)	191.84	21.08		

Table 6 resembled at 195 cc volume of small intestine control patients got 53.40 Gy radiation dose while patients with belly board (cases) received only 36.99 Gy which is statistically highly significant (*p-value*<0.001). At 100% volume of bladder control patients got 52.13 Gy radiation dose while at the same volume patients with belly board (cases) received only 49.79 Gy which is statistically not significant (*p-value*<0.1).

Table 6. *Comparison of different doses across arms.*

Arm		Mean Dose (Gy)	SD	t-value	*p*-value
At 195 cc volume of small intestine	A (control)	53.403	4.2132	13.219	<0.001
	B (case)	36.987	5.3405		
At 100% volume of bladder	A (control)	52.133	4.0079	6.314	<0.1
	B (case)	49.793	5.0882		
At 5% volume of right femoral head	A (control)	45.773	3.9938	2.920	<0.1
	B (case)	44.750	4.1673		
At 5% volume of left femoral head	A (control)	46.113	3.3672	2.015	<0.1
	B (case)	46.803	3.7690		

4. Discussion

Gastrointestinal (GI) toxicity is the most frequently encountered complication of pelvic radiation therapy with clinically significant acute and late toxicity occurring in up to 60% and 20% of patients, respectively [8]. Radiation damage to small bowel tissue can cause acute or chronic radiation enteritis producing symptoms such as pain, bloating, nausea, fecal urgency, diarrhea and rectal bleeding which can have a significant impact on patient's quality of life [9]. Prone positioning on a belly board (PBB) is a simple but effective method for physically displacing small bowel away from target structures within the pelvis. Three-dimensional treatment planning studies have demonstrated that PBB significantly reduces the volume of small bowel receiving prescription doses [4]. In this study the mean volume of small bowel received 45Gy is 351.85cm^3 in arm A (control) and 191.84 cm^3 in arm B (case) (*p-value*<0.001). In an American study patients received 45Gy in 299 cm^3 of small bowel volume without belly board insupine position and received 45Gy in 102 cm^3 of small bowel volume with belly board in prone position [10]. In this study, the total irradiated mean volume of small bowel was 2987.07cm^3 in arm-A (control) whereas the total irradiated meal volume of small bowel was 1687.18 cm^3 in arm-B (case) (*p-value*<0.001). This almost 50% reduction of irradiated mean small bowel volume resulting less acute and late complication thus improving patient compliance which is also supported by Shanahan T. *et al.* (1990). In their study they showed that 66% of displacement of small bowel volume in prone position with belly board.

In the current study, 195cc of small bowel volume received radiation dose considerably low in arm-B (53.40Gy vs. 36.99Gy, *p-value*<0.001). While some other structures like urinary bladder (52.13Gy vs. 49.79 Gy, *p-value*<0. 1), right femoral head (45.77Gy vs. 44.75Gy *p-value*<0. 1) and left femoral head (46.11Gy vs. 46.80Gy, *p-value*<0. 1) received almost equal dose in both treatment position. Similar result was observed in a study conducted in Finland where dose to the bladder and other pelvic structures in both supine and prone position with belly board was almost same [11].

Because of the proven efficacy of combined treatment with chemotherapy and radiotherapy to the pelvis for carcinoma cervix and carcinoma rectum, a higher rate ofgastrointestinal and genitourinary toxicity can be anticipated. Therefore, non- interventional modalities that reduce gastrointestinal symptoms yet allow sufficient tumoricidal dose delivery without increasing morbidity are desired. The belly board device offers a simple, inexpensive, noninvasive modality to decrease the toxicity associated with chemoradiation.

5. Conclusion

This small bowel volume reduction is seen in pre and postoperatively irradiated patients, might result in a reduced Gastro-intestinal morbidity. The patient position did not influence the required PTV margins for radiation planning of pelvic malignancy. In resource challenged setting where IMRT facilities for sparing vital organ like small bowel are limited this prone treatment position with belly board could be a reasonable choice.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Gallagher MJ, Brereton HD, Rostock RA, Zero JM, Zekoski DA, Poyss LF, Richter MP, Kligerman MM. A prospective study of treatment techniques to minimize the volume of pelvic small bowel with reduction of acute and late effects associated with pelvic irradiation. International Journal of Radiation Oncology* Biology* Physics. 1986 Sep 1; 12(9): 1565-73.

[2] Letschert JG, Lebesque JV, Aleman BM, Bosset JF, Horiot JC, Bartelink H, Cionini L, Hamers JP, Leer JW, Van Glabbeke M. The volume effect in radiation-related late small bowel complications: results of a clinical study of the EORTC Radiotherapy Cooperative Group in patients treated for rectal carcinoma. Radiotherapy and Oncology. 1994 Aug 1; 32(2): 116-23.

[3] Ghosh K, Padilla LA, Murray KP, Downs LS, Carson LF, Dusenbery KE. Using a belly board device to reduce the small bowel volume within pelvic radiation fields in women with postoperatively treated cervical carcinoma. Gynecologic oncology. 2001 Nov 1; 83(2): 271-5.

[4] Das IJ, Lanciano RM, Movsas B, Kagawa K, Barnes SJ. Efficacy of a belly board device with CT-simulation in reducing small bowel volume within pelvic irradiation fields. International Journal of Radiation Oncology* Biology* Physics. 1997 Aug 1; 39(1): 67-76.

[5] Uno T, Itami J, Shiina T, Araki H, Sakai M, Arimizu N. Evaluation of compression radiotherapy in pelvic treatment. Nihon Igaku Hoshasen Gakkai zasshi. Nippon Acta Radiologica. 1995 Jun 1; 55(7): 501-4.

[6] Perez CA, Grigsby PW, Camel HM, Galakatos AE, Mutch D, Lockett MA. Irradiation alone or combined with surgery in stage IB, IIA, and IIB carcinoma of uterine cervix: update for a nonrandomized comparison. International Journal of Radiation Oncology* Biology* Physics. 1995 Feb 15; 31(4): 703-16.

[7] Olofsen-van Acht M, van den Berg H, Quint S, de Boer H, Seven M, de Koste JV, Creutzberg C, Visser A. Reduction of irradiated small bowel volume and accurate patient positioning by use of a bellyboard device in pelvic radiotherapy of gynecological cancer patients. Radiotherapy and Oncology. 2001 Apr 1; 59(1): 87-93.

[8] Creutzberg CL, van Putten WL, Koper PC, Lybeert ML, Jobsen JJ, Wárlám-Rodenhuis CC, De Winter KA, Lutgens LC, van den Bergh AC, van der Steen-Banasik E, Beerman H. The morbidity of treatment for patients with Stage I endometrial cancer: results from a randomized trial. International Journal of Radiation Oncology* Biology* Physics. 2001 Dec 1; 51(5): 1246-55.

[9] Stacey R, Green JT. Radiation-induced small bowel disease: latest developments and clinical guidance. Therapeutic advances in chronic disease. 2014 Jan; 5(1): 15-29.

[10] Shanahan TG, Mehta MP, Bertelrud KL, Buchler DA, Frank LE, Gehring MA, Kubsad SS, Utrie PC, Kinsella TJ. Minimization of small bowel volume within treatment fields utilizing customized "belly boards". International Journal of Radiation Oncology* Biology* Physics. 1990 Aug 1; 19(2): 469-76.

[11] Finney R. Treatment of carcinoma of the bladder by external irradiation—A clinical trial part III. Clinical radiology. 1980 Jan 1; 31(4): 423-5.