DETERMINING THE EFFICIENCY OF A COMMERCIAL BELLY BOARD DEVICE IN REDUCING SMALL BOWEL VOLUME IN RECTAL CANCER PATIENTS

Dushko Lukarski[1], Sonja Petkovska[1], Natalija Angelovska[1], Biljana Grozdanovska[1], Nenad Mitrevski[1],

[1] University Clinic for Radiotherapy and Oncology, Vodnjanska 17, Skopje, R. Macedonia, duskol@yahoo.com.

***Abstract* – The purpose of this treatment planning study was to evaluate the efficiency of a commercial belly board device in reducing the irradiated volume of the small bowel.**
In this study 10 patients with rectal carcinoma receiving postoperative radiotherapy were included. For each of them we made two computer tomography series in prone position. In the first one the patients were lying on the flat table top, and in the second one they were lying on the belly board device which is under investigation. On both series we calculated and optimized plans according to the standing protocol of our department. From the dose-volume histograms of these plans we compared the volumes of the small bowel irradiated to three dose levels – 15, 30 and 45 Gy.
The results showed that the absolute irradiated volumes were significantly smaller in the plans with the belly board device.
Based on these results we believe that the employment of this belly board device will reduce the acute and late small bowel toxicity. This should be verified with a clinical study.

***Keywords* – belly board, rectal cancer, small bowel.**

1. INTRODUCTION

Radiotherapy, alone or in combination with chemo-therapy, plays a very significant role in the treatment of rectal cancer. The most important organ at risk (OAR) in the pelvic irradiation, often limiting the treatment, is the small bowel. Several studies [1, 2, 3] show that both acute and late small bowel toxicity is influenced by the volume of the small bowel that is irradiated. Various methods are devised for reducing that volume, both surgical and nonsurgical. Some of the surgical methods include placement of permanents silastic prosthesis, insertion of an absorbable synthetic mesh or omental sling, retroversion of the uterus, and reperitonealization of the pelvic floor. From the nonsurgical methods, the most common are the bladder distension method [4, 5] and employment of a belly board device.

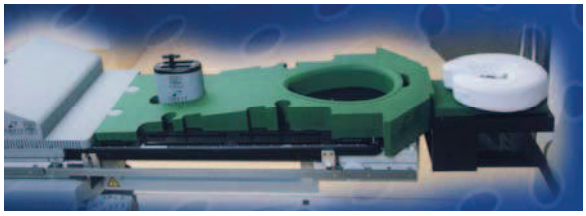

Fig.1 - The belly board device under investigation

This treatment planning study was intended for verification of one such commercially available belly board device, which our institution has obtained - AIO Bellyboard & Pelvic by the Orfit Industries (Fig. 1).

2. MATERIALS AND METHODS

2.1. Patient population and contouring

A total of 10 patients receiving postoperative radiotherapy were included in this study. In the whole number of patients, an overall stage II was present in 4 patients (40%), another 4 patients (40%) had an overall stage II, while the remaining 2 patients (%) were presented with a recurrent tumor.

Target volumes and OAR were delineated in all axial CT slices according to the recommendations of the RTOG and the ICRU respectively.

The target volumes were defined on the basis of the full bladder scan. The CTV included the macroscopic tumor, rectum, internal, common iliac and presacral LNs. The upper border was at level L5-S1. The posterior and lateral margins of CTV extend to lateral pelvic sidewall musculature or, where absent, the bone. Anteriorly, CTV was extended 1 cm into

the posterior bladder, to account for day-to-day variation in bladder position. Also in the mid pelvis we included at least the posterior portion of the internal obturator vessels (which lie between the external and internal iliacs in the mid pelvis).

The volume PTV was outlined as the CTV with 1 cm margin in all directions. The following OAR were delineated: bladder and small bowel. The small bowel (SB) structure consists of the following: small and large bowel as a whole peritoneal cavity exept for LNs, muscles, and OAR other than the SB. The upper border of SB was 1 cm above the PTV.

2.2. Description of the treatment technique

For each patient 2 CT series in prone position were made, with slice thickness of 5 mm. In the first CT series the patient was lying on the flat table top and in the second one he was placed on the belly board. All patients were irradiated without the belly board, according to the standing protocol of our institution.

The treatment planning was conducted using the Eclipse Version 7.3.10, a commercial 3-D treatment planning system manufactured by Varian Medical Systems.

The standing irradiation protocol for postoperative radiotherapy of rectal cancer at our department is irradiation of the PTV by 3 isocentric fields – one dorsal and two lateral photon fields with dynamic wedges (Varian's Enhanced Dynamic Wedge 60°). The beam quality of the dorsal field is 6MV and that of the lateral fields is 15MV. Roughly one half of the dose is delivered by the dorsal field and the other half by the lateral fields, whose weights are similar. The fractionation scheme is 28 fractions, 1.8 Gy each.

The isocenters of the two plans were chosen in such a manner that the shielded part of the small bowel in the beam's eye view of both plans was roughly the same. In such a way we were trying to make the plans as similar as possible, in order to exclude the influence of the treatment planning process on the irradiated volume of the small bowel and to evaluate only the influence of the belly board.

2.3. Evaluation and analysis

For each patient we analyzed the dose volume histogram (DVH) for both plans. The focus of the analysis was the small bowel [6-11]. We compared the volumes of the small bowel receiving 15, 30 and 45 Gy both in cubic centimeters and as a percentage of the contoured volume.

In the analysis we compared the means of the respective volumes using the non-parametric Wilcoxon exact signed rank test. Statistical significance was assumed at the level of $p \leq 0.05$.

3. RESULTS AND DISCUSSION

In Table 1 the comparison of the plans with and without belly board is given. We compared the means of the PTVs, the volumes of the SB (V_{total}) and the volumes of the SB receiving 15, 30 and 45 Gy (V_{15Gy}, V_{30Gy} and V_{45Gy} respectively) both in cubic centimeters and as a percentage of the total volume. The p value of the corresponding comparison is given in the last column.

Table 1. Comparison of the DVH parameters for the plans with and without belly board

	Without BB	**With BB**	**p**
PTV (cm^3)	1423 ± 268	1405 ± 289	0.139
V_{total} (cm^3)	717 ± 205	640 ± 343	0.169
V_{15Gy} (cm^3)	636 ± 185	536 ± 264	0.015
V_{30Gy} (cm^3)	432 ± 143	371 ± 172	0.022
V_{45Gy} (cm^3)	329 ± 130	275 ± 149	0.007
V_{15Gy} (%)	88.8 ± 4.0	87.0 ± 10.4	0.721
V_{30Gy} (%)	60.8 ± 12.3	62.6 ± 14.0	0.647
V_{45Gy} (%)	45.8 ± 11.0	45.7 ± 13.1	0.959

On Figure 1 we give typical DVHs for the SB of a patient.

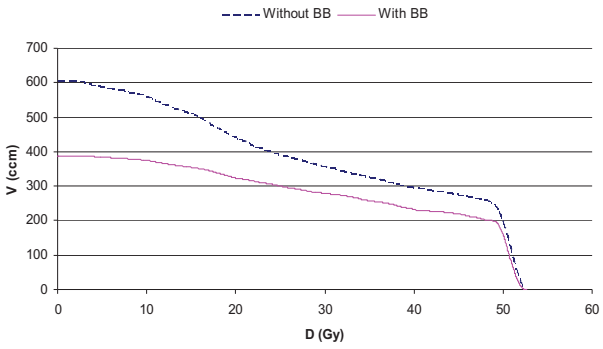

Fig. 1 – Dose-volume histogram comparison of the small bowel with and without the belly board device

As presented in the table, the difference between the planning target volumes was not significant. Also, the difference between the total contoured volumes of the small bowel was not statistically significant.

When we compared the volumes of the SB as an absolute value (in cubic centimeters), for all three dose levels under investigation (15, 30 and 45 Gy) the plan with the belly board showed significantly smaller volumes irradiated. This was also evident from the dose volume histograms for different patients.

However, as a percentage of the total volume, there was no statistically significant difference in the volumes receiving 15, 30 or 45 Gy.

Since the literature suggests that the important parameter for prediction of both acute and late small bowel toxicity is the absolute volume of the small

bowel irradiated, we would conclude that the usage of the belly board device would reduce this volume, and thus, reduce the risk of small bowel toxicity.

4. CONCLUSION

The results of this treatment planning study showed that by employment of this particular commercial belly board device we can reduce the absolute irradiated volume of the small bowel. Since the literature shows that both the acute and the late toxicity depend on this absolute irradiated volume, we would recommend a clinical study to compare the toxicity for two series of patients, one with and one without the belly board device.

5. REFERENCES

[1] Kavanagh BD et al., *Radiation Dose-Volume Effects in the Stomach and Small Bowel*, Int J Radiat Oncol Biol Phys, 76 (3), 2010, S101-S107.

[2] Huang EY et al., *The Different Volume Effects of Small-Bowel Toxicity During Pelvic Irradiation Between Gynecologic Patients With and Without Abdominal Surgery: A Prospective Study With Computed Tomography Based Dosimetry*, Int J Radiat Oncol Biol Phys, 69 (3), 2007, 732-739.

[3] Robertson JM et al., *The Dose-Volume Relationship of Small Bowel Irradiation and Acute Grade 3 Diarrhea During Chemoradiotherapy for Rectal Cancer,* Int J Radiat Oncol Biol Phys, 70 (2), 2008, 413-418.

[4] Gallagher MJ et al, *A prospectivestudy of treatment techniques to minimize the volume of pelvic small bowel with reduction of acute and late effects associated with pelvic irradiation*, Int J Radiat Oncol Biol Phys, 12, 1986, 1565-1573.

[5] Gunderson et al., *Treatment planning for colorectal cancer: Radiation and surgical techniques and value of small-bowel films*, Int J Radiat Oncol Biol Phys, 11, 1985, 1379-1393.

[6] Shanahan TG et al. *Minimization of small bowel volume within treatment fields utilizing customized "belly boards"*, Int J Radiat Oncol Biol Phys, 19, 1990, 469–476.

[7] Kim TH et al, *Comparison of th belly board device method and the distended bladder method for reducing irradiated small bowel volumes in preoperative radiotherapy of rectal cancer patients*, Int J Radiat Oncol Biol Phys, 62 (3), 2005, 769-775.

[8] Martin J et al., *Treatment with a belly-board device significantly reduces the volume of small bowel irradiated and results in low acute toxicity in adjuvant radiotherapy for gynecologic cancer: results of a prospective study*, Radiother Oncol, 74, 2005, 267–274.

[9] Das IJ et al., *Efficacy of belly board device with CT-simulation in reducing small bowel volume within pelvic irradiation fields,* Int J Radiat Oncol Biol Phys, 36 (1), 1996, S56.

[10] Koelbl O, Vordermark D, Flentje M. *The relationship between bellyboard position and patient anatomy and its influence on dose–volume histogram of small bowel for postoperative radiotherapy for rectal cancer,* Radiother Oncol, 67, 2003, 345–349.

[11] Koelbl O, Richter S, Flentje M. *Influence of patient positioning on dose-volume histogram and normal tissue complication probability for small bowel and bladder in patients receiving pelvic irradiation: a prospective study using a 3D planning system and a radiobiological model,* Int J Radiat Oncol Biol Phys, 45, 1999, 1193–1198.