

Dose–volume histograms associated to long-term colorectal functions in patients receiving pelvic radiotherapy

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Abstract

Background and purpose: To correlate long-term colorectal dysfunctions following radical radiotherapy for bladder or prostate cancer with clinical parameters and dose–volume histogram parameters of the small intestine, rectum, and anal canal volume.

Materials and methods: Seventy-one patients previously treated for bladder or prostate cancer were interviewed following CT-based radiotherapy of 60–70 Gy with questions concerning long-term colorectal dysfunctions. Median follow-up time was 30 months (range 12–109 months). Clinical parameters and parameters from the dose–volume histograms were correlated with colorectal dysfunctions (Spearman's test). Median and quartile values of all parameters were used as cut-off values for statistical analyses. A logistic regression model was used for analysis of urgency and incontinence in relation to median or maximum radiation dose to the anal canal volume.

Results: Rectum length, volume and several dose–volume parameters from the anal canal volume and rectal volume were correlated with late organ dysfunctions. In a logistic model, fecal urgency and incontinence were dependent of dose–volume parameters from the anal canal volume. No relation between age or follow-up time and late effects were found. Dose–volume parameters of the small intestine were not related to any late dysfunctions.

Conclusions: A relationship between several late anorectal dysfunctions and dose–volume parameters from the rectum and anal canal volume was demonstrated. It is recommended to exclude the anal canal volume from the high dose–volume and to apply rectal shielding whenever possible to prevent late anorectal dysfunctions.

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1. Introduction

Radical radiotherapy for pelvic tumours is associated with late effects from normal tissues included in the irradiated volume. Previous studies have in particular focused on rectal bleeding as a potential dose limiting side effect and demonstrated an association between doses above 50–70 Gy and an increased risk of late rectal bleeding [11,14,15,19,24]. However, other anorectal and small intestine late effects such as urgency in connection to bowel movements, diarrhoea, increased frequency and fecal leakage have been recognised [4,17,20]. These symptoms have a large impact on the quality of life. Attempts to

identify dose–volume parameters that might predict rectal toxicity have been made [5,12,21,26,27].

New treatment techniques such as intensity-modulated radiotherapy (IMRT) can deliver higher doses to the target and reduce radiation doses to critical normal tissues. However, to keep toxicity at an acceptable low level, knowledge concerning dose–volume parameters and toxicity within each critical normal tissue is warranted [3].

Dose–volume parameters can be presented in the dose–volume histogram. The shape of the dose–volume histogram depends on treatment related parameters. These include treatment technique and definitions of the target as well as organs at risk.

The aim of the present study was to investigate the relationship between parameters from dose–volume histograms of the anal canal, rectum and small intestine and late

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morbidity in a group of patients having received radical radiotherapy for bladder or prostate cancer in our institution.

2. Materials and methods

2.1. Patient populations

For the present study, we used data on late effects and dose–volume parameters from the treatment plan in patients who received radical radiotherapy for bladder cancer or prostate cancer in the period from 1994 to 2001.

Previously, we reported the data on late effects of the patients irradiated for bladder cancer. A structured telephone interview was used to assess late bladder, bowel and sexual dysfunctions in 53 patients and 63 population controls matched for age and sex. In conclusion, the patients reported significant bladder, bowel and sexual dysfunctions as compared to the population controls [17].

In the present study, we look for possible relationships between parameters from the dose–volume histograms and significant late effects. To obtain larger variation in doses to organs at risk, 27 consecutive patients previously irradiated for prostate cancer in our institution between 1994 and 2001 were considered as candidates for the present study. Two of these patients were dead and another 2 patients had recurrent cancer. Of the remaining 23 patients, 21 patients agreed to participate in the telephone interview.

The telephone interviews were performed between November 2002 and November 2003, with a median follow-up of 30 months (range 12–109 months) following radiotherapy. The Regional Ethics Committee of the County of Aarhus had approved the study. A written informed consent was obtained from all patients before entering the study.

Following the telephone interviews, the CT-dose plans were evaluated in all but three patients, i.e. two patients irradiated for prostate cancer and one patient irradiated for bladder cancer. For these patients, the treatment plan was not restorable. Thus, a total of 71 patients having received radical radiotherapy for pelvic tumors were included in the present study. Patient and treatment characteristics are summarised in Table 1.

2.2. Clinical endpoints

Bladder, small intestine and anorectal dysfunctions were scored in a structured interview with questions produced from the LENT/SOMA scoring system [2]. The questions for the interview were developed with forward and backward translation procedures and validation in our department [17].

In the present study, the following items concerning anorectal and small intestine function were analysed: Stool frequency, diarrhoea, fecal urgency, fecal incontinence, rectal bleeding and mucosal loss. Other endpoints for analyses were age, follow-up time, presence of diabetes mellitus and hypertension, organ volumes, and rectal length (Table 1). To reduce the risk of introducing bias, all clinical data were assessed without knowledge of anorectal and small intestine dose–volume histograms.

2.3. Radiotherapy

Treatment planning was based on a planning CT scan (1.0 cm spacing) obtained in the supine position with immobilisation by use of a custom-made polyurethane cast. Prior to the CT scan, a peroral contrast agent was ingested. The planning CT scan and the subsequent radiation treatments were performed after the patients had emptied the bladder. All patients were treated with

Table 1
Selected patients characteristics

	Bladder cancer (N=52)	Prostate cancer (N=19)	All patients (N=71)
Age, median years (range)	73 (50–82)	64 (54–71)	71 (50–82)
T-stage			
T1	6%	0%	NR
T2	37%	54%	NR
T3	52%	46%	NR
T4	6%	0%	NR
IRCU dose in Gy (range)	60 (60)	69.6 (66–70)	62.6 (60–70)
Follow-up, months, median (range)	29 (18–103)	31 (12–109)	30 (12–109)
Diabetes	6%	0%	4%
Hypertension	22%	32%	25%
Anal volume median cm ³ (range)	17 (9–29)	14 (7–22)	16 (7–29)
Rectum volume median cm ³ (range)	117 (47–369)	101 (37–193)	111 (37–369)
Small intestine volume ^a median cm ³ (range)	1171 (339–1979)	702 (85–1621)	1057 (85–1979)
Rectum length median cm (range)	12 (7–14)	12 (10–14)	12 (7–14)

NR, not relevant.

^a Absolute volume included in the CT-scan.

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