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Original Article

Does the Use of Volumetric Modulated Arc Therapy Reduce Gastrointestinal Symptoms after Pelvic Radiotherapy?

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Abstract

Aims: Growing numbers of patients with cancer are surviving after treatment with pelvic radiotherapy. We evaluated the technique of volumetric modulated arc therapy (VMAT), which delivers a decreased dose to the organs at risk. We aimed to determine outcomes of this technique in terms of patient-reported acute toxicity and late effects and correlate the frequency of gastrointestinal symptoms with the volume of bowel receiving radiation dose.
Materials and methods: Patients who were to receive VMAT for gynaecological malignancy completed patient-reported outcomes at baseline, the end of treatment, 8 weeks and 1 year. The rates of patient-reported toxicity were correlated with the volume of bowel irradiated.
Results: The frequencies of patient-reported gastrointestinal symptoms increased in the acute toxicity phase and tended to improve at 1 year, with the exception of faecal incontinence and rectal bleeding ($P < 0.05$). There was not a strong association between the volume of small bowel that was irradiated ($P > 0.05$ at all dose levels) and reported toxicity, suggesting that other factors are involved in the development of toxicity.
Conclusion: Although VMAT decreases the dose delivered to the small bowel, this does not translate into a reduction in patient-reported toxicity.

Key words: Gastrointestinal; gynaecological malignancy; toxicity; VMAT

Introduction

Volumetric modulated arc therapy (VMAT) has been shown to deliver a decreased radiation dose to the organs at risk than traditional conformal therapy on dosimetric studies [1,2]. It is hoped that this will lead to less gastrointestinal acute toxicity (and subsequent late effects). However, this has not yet been shown. In 2004, intensity modulated radiotherapy (IMRT) use in gynaecological malignancy in the USA was 27% [3]. VMAT has been in use since 2007 and is quicker than IMRT. The main disadvantages with VMAT are the cost in terms of set-up and the additional time needed to plan the treatment by the clinician and the planning team. Furthermore, the total body dose (or integral dose) is higher than conformal treatment so that a larger volume of the patient is bathed in low dose radiation. Due to the recent development of VMAT, it is not yet known whether this will lead to more secondary cancers in the long term. In particular, there is little known about the rates of acute toxicity and late effects secondary to VMAT.

Some limited acute toxicity data are available for IMRT in the setting of the treatment of gynaecological malignancy. IMRT was compared with conformal treatment in a retrospective study of 60 patients with postoperative endometrial and cervical cancer [4]. Intestinal toxicity was graded retrospectively using Radiation Therapy Oncology Group/European Organization for Research and Treatment of Cancer (RTOG/EORTC) criteria and was found to be lower in the IMRT group, although significance levels for this were not reported. At dose levels > 30 Gy significantly less dose was delivered to the small bowel with IMRT than conformal treatment. Thirty patients who received VMAT with simultaneous integrated boost for endometrial cancer were compared with 30 patients who received conformal therapy

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[5]. Toxicity was graded prospectively by physicians using the National Cancer Institute's Common Terminology Criteria for Adverse Events (CTCAE) grading system. The conformal group had significantly more gastrointestinal adverse events than the VMAT group. Further studies examining IMRT in the treatment of gynaecological malignancy are shown in Table 1.

Several studies have correlated bowel volume and radiation doses with gastrointestinal toxicity. One retrospective study in cervical cancer showed that bowel volume receiving >45 Gy was associated with increased gastrointestinal toxicity using RTOG criteria [16]. Of note in contouring, the whole peritoneal cavity was taken to represent the bowel. One study correlated rectal and sigmoid late effects with dose volume histogram parameters for magnetic resonance image-guided brachytherapy for cervical cancer [17]. They found that an increased rectal dose could be correlated with late rectal toxicity.

This prospective study aimed to determine the frequency of patient-reported gastrointestinal toxicity in gynaecological malignancy treated with VMAT and test the association of patient-reported diarrhoea with bowel radiation dose. The symptom of diarrhoea was chosen as this was felt to be the best surrogate marker of small bowel function rather than faecal urgency and incontinence, which are likely to be affected by the dose received by the rectum.

Materials and Methods

This study was approved as a clinical effectiveness project by the Clinical Audit Committee at The Christie NHS Foundation Trust. This was a prospective study including all patients receiving pelvic VMAT for gynaecological malignancy from December 2013 to July 2014. All patients completed the symptom questionnaire at their first outpatient appointment on their final day of external beam radiotherapy (end of week 4), 6–8 weeks after they completed treatment (at their first follow-up appointment) and at 1 year.

The symptom questionnaire contains validated patient-reported items derived from the CTCAE grading system [18]. The item scores for each question in the symptom questionnaire were grouped into three levels. These were no score (item score = 0), low (item scores = 1, 2) and high (item scores = 3, 4). Mean scores were calculated across the entire patient group for each symptom at each time point.

Radiotherapy Treatment Details

To obtain bowel dose volumes the 'bowel bag' was contoured by a clinical oncologist on each patient's treatment plan. This was carried out in line with the Interlace trial protocol. The 'bowel bag' should include any area where the bowel may move to during treatment. It is contoured from the anorectum (which is contoured separately) to 2 cm above the superior aspect of the planned treatment volume. Any other structures within the same area, such as the clinical target volume or the bladder, are then subtracted from the 'bowel bag' area. Therefore, the volume of bowel that receives 5 Gy up to the volume that receives 40 Gy can be calculated. The results were analysed with SPSS v22.

Results

Sixty-two patients were included and their demographics and treatment details are shown in Table 2. Following external beam radiotherapy, 30 patients received intracavitary brachytherapy, 17 received a conformal external beam boost and 15 received no further treatment. The numbers of questionnaires completed at baseline, the end of treatment, 6–8 weeks and 1 year were 57, 60, 50 and 42, respectively. One year after the end of treatment eight patients had died. Of the 42 patients who completed the 1 year questionnaire, 39 were known to be disease free. Three patients who completed the 1 year questionnaire were diagnosed with disease recurrence around that time but none had started further treatment, such as chemotherapy. Twelve patients did not fill in the 1 year questionnaire for reasons such as patient choice, palliative chemotherapy or lost to follow-up.

Patient-reported Bowel Symptoms

The frequency of patient-reported bowel symptoms at each time point were shown graphically. The mean item scores of each item at the end of treatment, 8 weeks and 1 year were compared with the baseline score using the Wilcoxon signed rank test. Figure 1 shows the frequency of diarrhoea at each time point and severity is graded by the frequency of bowel motions. Although 75% of patients reported diarrhoea at the end of treatment, only 57% reported this when asked to rate it by frequency. It is possible that some patient's symptoms were controlled by medication. The item score for diarrhoea was significantly higher at the end of treatment ($P < 0.005$) but not at 8 weeks or 1 year. The frequencies of patients taking anti-diarrhoeal medication at baseline, the end of radiotherapy, 6–8 weeks and 1 year were 11, 73, 14 and 12%, respectively.

Diarrhoea and faecal urgency (Figure 1) were reported by 16% and 48%, respectively, of patients at baseline. This proportion rose at the end of treatment but was seen to improve at 8 weeks and then 1 year. Faecal urgency did not return to baseline at 1 year, but remained present in 65% of the cohort. However, although the item score for faecal urgency was significantly higher than baseline at the end of treatment ($P < 0.005$) and week 8 ($P < 0.05$) it was not statistically significantly higher than baseline at 1 year. Faecal incontinence was reported by no patients at baseline but was reported by 29% of patients at the end of radiotherapy. At the 1 year time point, 24% of patients continued to report faecal incontinence (grade 3 incontinence reported by one patient only). The item score for faecal incontinence was statistically higher than the baseline score at the end of treatment ($P < 0.005$), 8 weeks ($P < 0.05$) and 1 year ($P < 0.05$).

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