Acute rectal toxicity: 3-Field versus 4-Field radiation treatment technique for prostate carcinoma

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Abstract

Radical radiotherapy is a common treatment for prostate carcinoma. Acute toxicity to the rectum, which lies posterior to the prostate, is dependant upon the field arrangement, dose delivered and volume of rectum that lies within the target volume. Due to technical limitations of their equipment, two different oncology centers in Durban are currently using two different treatment techniques. One uses the 3-field technique which avoids direct irradiation of the rectum, and the other uses the 4-field technique which involves direct irradiation of the rectum.

A prospective, convenience-sampling study was conducted to determine the degree of acute toxicity for these two radiation treatment techniques.

Sixty participants with histologically confirmed stage B or C prostate carcinoma were recruited from two private oncology centers in Durban. Thirty participants were treated with the 3-field technique and the other 30 with the 4-field technique. All participants were treated with a daily dose of 2.00Gy up to a total dose of 60.00Gy. Weekly acute rectal toxicity was assessed using the RTOG/EORTC grading criteria. Grade 1 toxicity was the highest in week 6 (26.7%) for the 3-field technique and in week 3 (23.3%) for the 4-field technique, grade 2 in week 6 (16.7%) for the 3-filed and in week 3 (6.7%) for the 4-field, whereas grade 3 toxicity was constant in weeks 2-5 (3.35) for the 3-field technique and highest in week 4 (16.7%) for the 4-field technique. No participants experienced grade 4 acute rectal toxicity. A statistically significant difference exists between the techniques which was exhibited in week 2 ($p=0.0002$). Participants treated with the 3-field technique experienced less severe acute rectal toxicity than those treated with the 4-field technique.

Keywords: *Prostate carcinoma, radical radiotherapy, acute rectal toxicity.*

Introduction

Prostate cancer causes a substantial public health burden worldwide. Carcinoma of the prostate develops in approximately 300 000 males each year worldwide. It is a unique disease in that it exhibits late clinical signs and symptom, which has consequently resulted in the need for histologic and biochemical methods of detection of the disease in its early stages [1,2].

According to the National Cancer Institute (NCI) of South Africa (SA) [2], 2621 new cases were reported to the NCI between1993-1995. One in 31 South African males has a lifetime risk of developing the disease given the prevailing incidence of 58.7 per 100000 and 13 per 100000 for White and Black males respectively (Figure 1) whereas the incidence for Colored males and Asian males is comparatively lower [2].

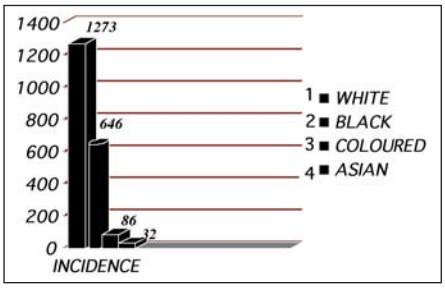

Figure 1: Incidence of prostate cancer in South African males (Sitas et al. 1998)

The prostate gland (Figure 2) [3] is a walnut-shaped organ weighing approximately 20 grams. The gland contributes 95% of the fluid in semen. It is a component of the male reproductive system lying just posterior to the pubic symphysis and being related anteriorly to the bladder and posteriorly to the rectum [4].

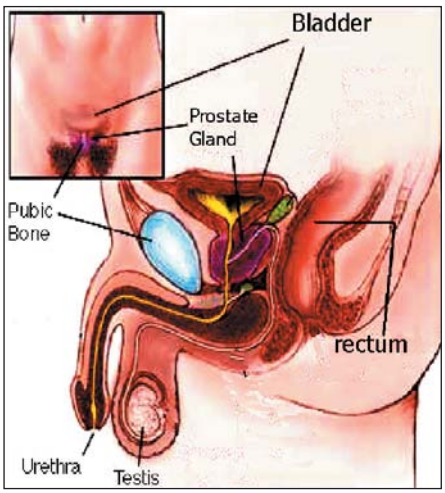

Figure 2: The prostate gland and its anatomic relation to the bladder and rectum (http:\\capcure.org/ aboutprostate/prostate.html)

During radiotherapy treatment of the gland varying degrees of unavoidable radiation occurs to both the bladder and rectum which leads to acute toxicity of these structures.

The goal of treatment of local and locally advanced prostate cancer is to cure without causing unacceptable complications. Amongst the avenues being explored in an attempt to reduce unacceptable complications are varying the field arrangement, the field size, and the dose regimes used are continuously being evaluated [5-7]. The current study evaluated the three field and the four field radiation treatment technique with reference to the severity of the acute rectal toxicity experienced during the course of treatment.

Methodology

This includes sample size, inclusion and exclusion criteria and ethical considerations pertaining to research.

Sample size and selection

The sample consisted of 60 participants in total. Participants from two private practice oncology departments were selected using the convenience method of sampling. Groups A and B consisted of 30 participants each. Those in group A received treatment using the 3-Field technique whereas those in group B received treatment using the 4-Field technique (Figure 3). The 3-Field technique encompasses two fields directed laterally at the pelvis with the third field directed form the anterior aspect of the patient. The 4-Field technique encompasses two fields directed laterally at the pelvis, one field directed from the anterior of the patient and one field directed from the posterior aspect of the patient.

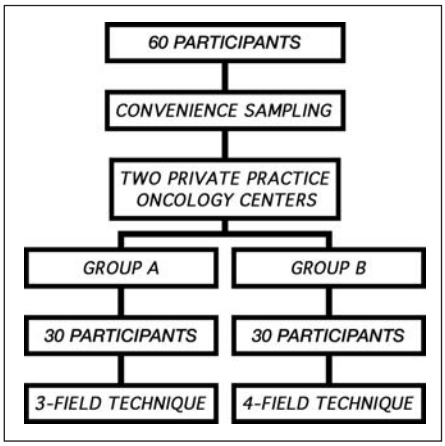

Figure 3: Summary of study population

Inclusion and exclusion criteria

All participants had to have been diagnosed with histologically confirmed stage B or C prostate cancer. The histology specimen was obtained using transurethral resection of the prostate or, transrectal or transurethral biopsy of the prostate gland. Some of the participants were on hormonal therapy but this was not an exclusion criterion. Compulsory investigations prior to being selected for the study included computerisd tomography (CT) of the pelvis for diagnostic, staging, planning and monitoring purposes. All participants had

prostate specific antigen tests prior to and during the treatment for monitoring purposes.

Potential participants with hip replacements were not included in the study since these participants required alternative field arrangements in order to compensate for the metal prostheses.

Ethical considerations

The study procedure was verbally discussed with each participant. A written version of the verbal explanation was handed to each potential participant to read at home. Signed informed consent was thereafter obtained from each participant. Ethical approval to conduct the study was obtained from the Durban Institute of Technology, the hospital managers and the heads of departments of the two private practices.

Planning and treatment

After the oncologist assessed the participant and the relevant investigations were completed, the radiation treatment plan was generated. Following this the participant was simulated and field markings marked on the treatment area. Radiation therapy then commenced with the participant receiving 2.00 Gy daily x 30 treatments 5/7 to a total dose of 60.00 Gy. Hereafter the field arrangements were modified and a further 10.00 Gy to 20.00 Gy was then given using the new field arrangement. This study evaluated the participants until a dose of 60.00Gy was reached (Figure 4).

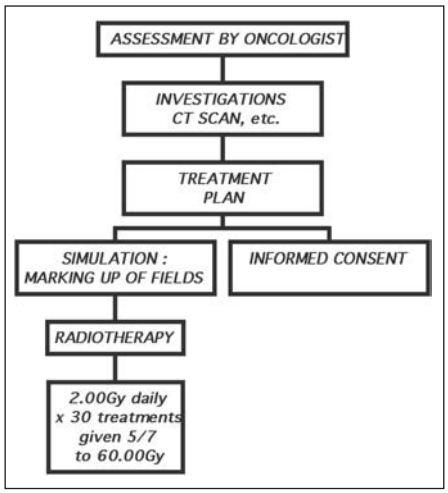

Figure 4: Summary of Radiation treatment planning

Assessment of toxicity

Acute radiation toxicity to the rectum was assessed and graded using the RTOG grading criteria (Figure 5) [8]. The RTOG criteria states that:

- Grade 0 refers to no diarrhoea,
- Grade 1 refers to transient diarrhoea for less than 2 days,
- Grade 2 refers to tolerable diarrhoea occurring more than 2 days,
- Grade 3 refers to intolerable diarrhoea requiring intervention, and
- Grade 4 to haemorrhagic diarrhoea.

After every five radiation treatments were

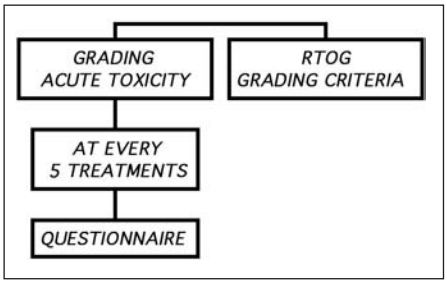

Figure 5: Summary of procedure for grading acute rectal toxicity

completed, the participants were asked questions from a piloted questionnaire regarding acute rectal toxicity (Figure 6).

GRADE	SIGN / SYMPTOM
0	No diarrhoea
1	Transient diarrhoea (≥ 2 days)
2	Tolerable diarrhoea (> 2 days)
3	Intolerable diarrhoea (requires treatment)
4	Haemorrhagic dehydration

*Figure 6: RTOG GRADING (*Muller et al. 1981*)*

Data analysis

The researcher entered and did the relevant statistical tests for the data recorded on the questionnaire. The data were then analyzed using the SPSS package with the help of a statistician. The test used was the two sample unpaired t-test as the study was a parametric one. There were 30 patients in each group. The null hypothesis (Ho) stated that there was no significant difference between the two groups, whereas the alternative hypothesis (H1) stated that there was a significant difference between the two groups. Ho was to be rejected if the p value was less than or equal to (α/2, where the level of significance for α was 5% or 0.05.

Results

A statistical significance between the two groups was demonstrated in week 2 where the p value was 0.022, resulting in the Ho being rejected. The results demonstrated graphically (Figure 7)

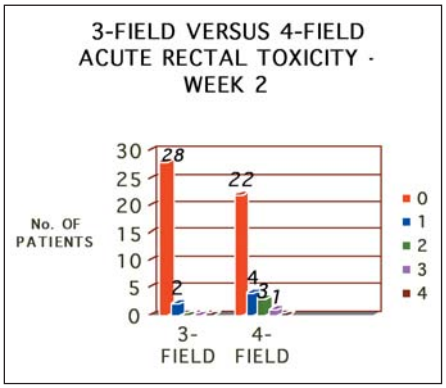

Figure 7: Histogram demonstrating results of study

indicate that of the 30 participants in the 3-Field technique group, 28 participants experienced Grade 0 toxicity and the remaining two experienced Grade 1 toxicity.

Of the 30 participants in the 4-Field technique group, 22 experienced Grade 0 toxicity, and out of the remaining eight, four experienced Grade 1 toxicity, and three experienced Grade 2 toxicity, and only one experienced Grade 3 toxicity.

Discussion

The sensitivity of the method used for assessing acute rectal toxicity was not the ideal for the following reasons. There would have been greater sensitivity if testing the stool for occult blood accompanied the questionnaire. Histologic sampling of the rectal tissue could also be used to complement the questionnaire and stool testing. The problem with the histologic sampling, no matter how minimal, is that the procedure used to obtain the sample is invasive and the rectal lining is already quite sensitive due to the radiation. The sampling would cause further injury to the lining thus rendering it even more sensitive.

The dose (60.00Gy) used to treat the prostate gland is not sufficient to produce excessive acute rectal toxicity. As stated previously, the field arrangement and the field sizes were modified after 60.00Gy was reached and these two factors varied from participant to participant.

The method of sample selection was not ideal for two reasons. First the participants were selected using the convenience method of sampling, which although is a statistically acceptable method, is not the method of choice. However the participants could not be randomly allocated into the two groups if the best interest of each participant was considered. The size, shape and the configuration of any tumor is unique therefore custom planning is done to ensure that the field arrangement and size is the most appropriate for that particular tumor. The oncologist selected the most appropriate treatment plan generated for each participant.

Only participants from two private practice oncology centers were included in this study. This was because the other oncology centers in the city use different field arrangements and dose regimes compared to those evaluated in the current study. Although the sample is quite representative of the population, it is not a true reflection of the general population in the Province of KwaZulu-Natal. Bias with respect to race and consequently diet, occupation and socio-economic factors may have been introduced into the study.

Conclusion

The 4-Field technique exhibited more severe acute rectal toxicity than the 3-Field technique in participants evaluated in this study. The implications of such a finding impacts on the choice of field arrangement that is more ideal in terms of decreased acute rectal toxicity. Future studies need to be conducted on a more general population rather than a restricted one.

Long-term follow-up is required to evaluate the differences between the two techniques used in the current study in terms of chronic rectal toxicity and disease free survival.

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