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Original Article

Feasibility of Nighttime Radiotherapy for Physically Independent Patients

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ABSTRACT

Objective: Daily hospital visits for radiation therapy during working hours, five days a week, are sometimes burdensome to cancer patients who are working or studying. The purpose of this study was to evaluate the feasibility and safety of night-time radiation therapy for physically independent patients.
Methods: This retrospective study consisted of 100 consecutive patients with various types of malignancies treated by helical tomotherapy at night (6:00 PM or later). The safety and feasibility of nighttime radiation therapy were evaluated.
Results: Among the 100 patients, 20 (20%) developed mild (Grade 1) or moderate (Grade 2) radiation-induced side effects during the treatment. No patient developed severe (Grade 3) or life-threatening (Grade 4) adverse events during, immediately after, or three months after radiation therapy. There were no physical or mental disadvantages caused by night-time radiation therapy.
Conclusion: Night-time radiation therapy is feasible and acceptable for physically independent patients.

Introduction

Cancer patients who receive most types of external-beam radiation therapy usually have to travel to the hospital up to five days a week for several weeks. In general, smaller fraction sizes are associated with reduced incidence and severity of late-onset side effects in normal tissues [1]. However, it is sometimes hard for employed workers to go to hospital during working hours, five days a week. To alleviate the social and economic burden, we experimentally started nighttime radiotherapy for patients who are able to carry on normal activities and to work with no special care needed. The purpose of this study was to evaluate the feasibility and safety of nighttime radiation therapy for ambulatory patients.

Materials and Methods

I Eligibility Criteria

To be eligible for participation in this study, patients had to be at least 18 years of age, have histologically confirmed evidence of malignancy, an Eastern Cooperative Oncology Group (ECOG) performance-status (PS) score of 0 or 1 (on a scale from 0 to 5, with 0 indicating no symptoms and higher scores indicating increasing disability) and wish to receive external-beam radiation therapy at 6:00 PM or later. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008, and all patients provided written informed consent.

II Study Design

This retrospective study consisted of 100 consecutive patients with various types of malignancies treated by external beam radiation therapy alone at our institution between March 2013 and December 2013. The primary objective was to evaluate the safety and feasibility of nighttime radiation therapy for physically independent patients.

III Radiotherapy

All patients (64 male, 36 female) were treated with helical tomotherapy (Figure 1a) at our institution. In brief, helical tomotherapy is a rotational

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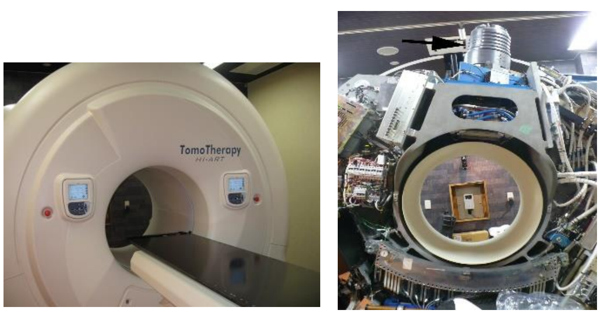
delivery technique that is similar to a helical computed tomography (CT) scan [2]. A small 6 MV linear accelerator mounted on a CT gantry continuously rotates about the patient, and radiation is delivered helically with the gantry and couch in simultaneous motion (Figure 1b). Intensity-modulated radiation therapy (IMRT) delivery is achieved by moving 64 individual multileaf collimators (MLCs) into and out of a narrow fan beam. MLC has two sets of interlaced leaves that move in and out very quickly to constantly modulate the radiation beam as it leaves the accelerator, which allows for distributions of the dose of radiation highly conformal to the target and minimizes the irradiation to the adjacent dose-limiting organs. No patient received chemotherapy during radiotherapy. Total radiation doses ranged from 12 to 76 Gy (mean +/- standard deviation: 60.1 +/- 16.2 Gy) over 5–41 days using a daily fraction size of 1.2–12 Gy (mean +/- standard deviation: 2.3 +/- 1.3 Gy). Sites of radiotherapy were prostate (n=38, 38%), breast (n=21, 21%), hepato-biliary-pancreatic region (n=17, 17%), colon and rectum (n=9, 9%), lung (n=8, 8%), and others (n=7, 7%). Adverse events were assessed during radiotherapy and for 1–3 months after the last dose was administered according to the National Cancer Institute Common Terminology Criteria for Adverse Events, version 4 [3].



A B

Figure 1: (**A**)Helical tomotherapy machine covered (**B**) uncovered. Helical tomotherapy combines a 6 MV linear accelerator (arrow) mounted on a ring gantry with CT technology for image-guided intensity-modulated radiation therapy. An MV image detector is mounted opposite the linear accelerator for treatment verification.

IV Survey of Reasons for Choosing Nighttime Radiotherapy

Before or during radiotherapy, patients or their family members were asked orally why they had chosen the nighttime radiotherapy by either the attending physician or a nurse.

Results

Among the 100 patients, 20 (20%) developed side effects associated with radiation therapy during treatment. Seventeen (17%) patients developed grade 1 and three (3%) grade 2 radiation-induced side effects. Of 21 breast cancer patients, four patients developed grade 1 (n=3, 14%) or 2 (n=1, 5%) radiation dermatitis, one (n=1, 5%) patient developed grade 1 dyspepsia. Of 38 prostate cancer patients, seven (18%) patients developed grade 1 urinary disorders, one (3%) patient developed proctitis. One (1%) patient with gallbladder cancer was hospitalized due to hypoglycemia, which was not related to radiation therapy. During 1–3 months of follow-up, there were no physical or mental disadvantages caused by nighttime radiotherapy.

For the assessment of reasons why they chose nighttime radiotherapy, 53 replies were available either from patients or their family members: patients could not go to hospital every day because of their jobs (n=40, 40%), patients' family members were not available during the day (n=9, 9%), patients were going to school (n=2, 2%), patients needed to help other family members who had more severe problems (n=2, 2%), no reply or refusal to respond (n=47, 47%).

Discussion

The results of this study demonstrated the feasibility and safety of nighttime radiation therapy using helical tomotherapy for physically independent patients. There is no reason given why toxicity would be worse for nighttime radiation, especially for patients with a good performance status. To assess this, a comparison should have been made to matched patients treated during normal operations, or a prospective randomized controlled trial should have been done. Yet, truly-matched comparison study is unpractical since patients should be matched based on treatment, dose, fraction size, diagnosis, and performance status. Furthermore, safety, errors, and economic impact are the variables to be most altered by nighttime radiation. Anyhow, as far as we as we know, this is the first report on the assessment of nighttime radiation therapy. Since the most common protocol to give external beam radiation therapy is daily, five days a week (Monday through Friday) for several weeks, depending on the type and stage of cancer, these daily hospital visits will lead to a disturbance in working or studying. Without compromising the effectiveness and safety of fractionated radiation therapy, the night-time radiation therapy might be a solution for the problem.

According to the cancer statistics in Japan, one out of every two Japanese people will develop cancer during their lifetime, and one in four Japanese males and one in six Japanese females will die from cancer (Foundation for Promotion of Cancer Research, http://www.fpcr.or.jp/). About 34% of employees will take voluntary buyouts or be fired and 13% of self-employed workers will go out of business in Japan due to cancer (http://www.mhlw.go.jp/stf/shingi/). Thus, how to achieve a good balance between radiation therapy and their job is a major concern not only for employees but also for self-employed workers. The nighttime radiation therapy shown in this study seems to be a solution to cancer treatment while working. According to the results of health-adjusted life expectancy (HALE) analysis, the Japanese have the highest HALE of 188 countries [4]. Japanese men were expected to spend 71.1 years of their life in good health, compared with 86.4 years for Japanese women [4]. However, cancer incidence rates in Japan begin to increase after age 40 and continue to increase with age, depending on the type of cancer; that is, many people holding jobs will suffer from cancer while they are still working [5].

Therefore, achieving a balance between cancer therapy and employment is a pressing issue not only for a patient but for the entire economy. Radiation therapy, one of the main treatments for cancer, is usually well tolerated by physically independent patients and can be given on an outpatient basis, but it is sometimes hard for those who are working to go to the hospital during working hours, five days a week. The nighttime radiation therapy presented here might be a solution to the socioeconomic problem relevant to jobs.

There are several limitations in this study. First, all radiation therapy was given by helical tomotherapy, which is a novel treatment approach that combines IMRT delivery with in-built image guidance using megavoltage CT scanning. Because helical tomotherapy achieves a higher level of treatment precision than conventional radiotherapy, the results of this study may not always be applicable to any hospital where conventional radiotherapy is carried out. Second, only physically independent cancer patients were enrolled in this study. Patients with moderate or severe comorbidities were not treated at night. Because this nighttime radiation therapy was aimed at those who are working, this selection bias is not a limitation. Third, the extra expense of overtime wages for nighttime radiation therapy nighttime radiation therapy is not covered by Japanese public health insurance, so it was provided at no additional cost. Nighttime radiation therapy was done because of the need of patients and supported by the dedicated help of the medical personnel, and it may not always be possible or available everywhere in the world.

Conclusion

In conclusion, the results of a single institutional study cannot be generalized to others without further investigation, but nighttime radiation therapy seems feasible and acceptable for physically independent patients.

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None.

Conflicts of Interest

None.

Abbreviations

ECOG:	Eastern Cooperative Oncology Group.
PS:	performance status.
CT:	computed tomography.
IMRT:	intensity-modulated radiation therapy.
MLC:	multileaf collimator.
HALE:	health-adjusted life expectancy.

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