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Survey of Stereotactic Body Radiation Oncology for Early Staged Non-Small Cell Lung Cancer in China

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ABSTRACT

Purpose: To evaluate the current status of stereotactic body radiotherapy (SBRT) for early staged non-small cell lung cancer (NSCLC) at main cancer hospitals in China. Methods and Materials: The questionnaire was sent by mail and email to 21 hospitals, which include the patient enrollment, treatment technique, dose and fractionation, quality control, disease control and side effects. Results: Nineteen hospitals responded. It was found that SBRT has been used for early staged NSCLC in most of the hospitals participating in the survey. The patient characteristics and techniques were relatively consistent, but there were many controversies regarding dose fractionation and quality control. Conclusions: SBRT for early staged NSCLC has been applied at main cancer hospitals in China. However, considerable variation exists. The establishment of clinical guidelines and standardized quality control are crucial for further improvement.

KEYWORDS

Non-Small Cell Lung Cancer; Stereotactic Body Radiotherapy; Survey

1. Introduction

Stereotactic body radiotherapy (SBRT) is an emerging radiotherapy technique that delivers very high dose radiation in a limited number of fractions precisely to a tumor while minimizing dose to adjacent normal tissue. Advances in radiotherapy planning such as three-dimensional conformal radiotherapy (3DCRT) and intensity modulated radiation therapy (IMRT), motion control, and image guided radiation therapy (IGRT) during treatment delivery in the last decade have led to the application of this technique to several tumor sites [1]. Promising clinical results, especially for early staged NSCLC, have been reported worldwide, including those from China [2-4].

Because of its huge population, many of whom smoke, lung cancer has become the most common cancer in China [5]. Subsequently, China is expected to become tremendously for the performance of clinical lung cancer research in radiation oncology. Similarly, just as in the rest of the world, SBRT is becoming more and more important in China. Therefore, it is extremely important for the world to understand the current state of affairs in China. It will allow the Chinese community to become aware of its own successes, inconsistencies and variations, and it will allow the rest of the world to understand modern Chinese practice and the manner in which that practice might be able to be aligned with practice elsewhere. With this purpose, we conducted a survey of radiation oncologists from main cancer centers in China regarding their SBRT usage for early staged non-small cell lung cancer (NSCLC).

2. Methods and Materials

The survey included 13 multiple-choice questions followed by three questions regarding patient outcome. As shown in **Table 1**, the multiple-choice questions assessed the patient enrollment, treatment technique, dose and fractionation, and quality control approaches.

The survey was circulated to 21 hospitals. Responses

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Table 1. Questionnaire and responses.

Questions	Choices and responses			
Part 1: Patients selection and staging				
1. Percentage of inoperable early staged NSCLC	>95%	>75%	others	
	9	**6**	**3: 90%; 1: 80%**	
2. Pathology/cytology confirmation	Necessary	Non-necessary, informed consent	To the greatest extent, unavailable allowed	
	10	**4**	**5**	
3. ^{18}F-FDG PET staging	Necessary	Non-necessary	Depend on the indication	
	9	**3**	**7**	
4. Mediastinoscopy/EBUS	**0**	**6**	**13**	
Part 2: Simulation, planning and delivery				
5. 4D-CT simulation	Necessary	Non-necessary	Depend on the indication	
	1	**11**	**7**	
6. Breath/motion control	**2**	**9**	**8**	
7. Delivery techniques[#]	LINAC	Gamma knife	Cyberknife®	
	17	**3**	**1**	
Part 3: Dose and fraction				
	18 - 20 Gy × 3	10 Gy × 5	12.5 Gy × 4	others
8. Peripheral T1	**1**	**8**	**4**	**6**
Peripheral T2	**0**	**11**	**2**	**6**
	10 - 11 Gy × 5	8 Gy × 6	12.5 Gy × 4	others
9. Central T1	**2**	**9**	**0**	**8**
Central T2	**1**	**10**	**0**	**8**
Part 4: IGRT and QA/QC				
10. Cone-beam CT	Every treatment	First treatment	None	
	10	**5**	**4**	
11. Dry run	Every case	Periodic	None	
	5	**11**	**3**	
12. Dose QA/QC[#]	ionization chamber	film dosimeter	Ionization/semiconductor array	
	8	**7**	**7**	
13. TPS QA/QC[#]	Every case	Periodic	None	
	12	**3**	**4**	

[#]More than two techniques used in one hospital.

were collected and considered evaluable if at least partially completed. The survey results were presented as the percentage of evaluable responses for each question.

3. Results

3.1. Case Selection and Staging

Most hospitals (19/21) used SBRT to treat medically inoperable early staged NSCLC. Nine, three, one and six hospitals used SBRT for >95%, 90%, 80% and >75% of reported inoperable cases of early staged NSCLC, respectively. Most hospitals felt that pathologic/cytologic confirmation was necessary (10/19) or preferable (5/19), and non-necessary in 4/19 hospitals. PET/CT was necessary (9/19) or potentially important (7/16) for staging, while 3/16 felt that PET/CT was not necessary. No hos-

pital (0/19) felt that mediastinoscopy or endobronchial ultrasound (EBUS) was absolutely necessary for staging, though most (13/16) felt that it was potentially important. A minority (6/19) felt that it was not necessary in any situation.

3.2. Simulation, Planning and Delivery

Only one hospital (1/19) reported that four-dimensional computed tomography (4DCT) was necessary for treatment planning. The majority of hospitals reported that 4DCT was either unnecessary (11/19) or potentially necessary depending upon the situation. Similarly, a minority (2/19) reported that motion management via breath-hold was necessary, while the majority reported that it was either unnecessary (9/18) or potentially necessary given the situation (7/19). Most hospitals (17/19) used a linear accelerator-based (LINAC-based) system to deliver SBRT, while a minority used either the Gamma Knife (3/19) or Cyberknife® (1/19). A single hospital reported using both a LINAC and Gamma Knife to deliver SBRT to the lung.

3.3. Dose and Fraction

The dose and fractionation varied between centers, and also with clinical stage of disease. For peripheral T1 disease, the most frequent schedules were 18 - 20 Gy × 3 fractions (1/19); 10 Gy × 5 fractions (8/19); 12.5 Gy × 4 fractions (4/19); or some other regimen (6/19). For peripheral T2 disease, the most frequent schedules were 10 Gy × 5 fractions (11/19); 12.5 Gy × 4 fractions (2/19) or some other regimen (6/19); no hospital used 18 - 20 Gy × 3 fractions (0/19). For central T1 disease, the most frequent schedules were 10 - 11 Gy × 5 fractions (2/19); 8 Gy × 6 fractions (9/19); or some other regimen (8/19). For central T2 disease, the most frequent schedules were 10 - 11 Gy × 5 fractions (1/19); 8 Gy × 6 fractions (10/19); or some other regimen (8/19).

3.4. IGRT and QA/QC

Cone-beam CT based image-guided radiotherapy (IGRT) was practiced by most hospitals for every fraction (15/19); for only the first fraction (5/19); or not at all (3 centers using gamma-knife, and 1 using LINAC-based treatment). Dry run tests were performed before every case at 5/19 hospitals; periodically at 11/19 hospitals; and not at all at 3/19 hospitals. Treatment planning system (TPS) quality assurance and quality control (QA/QC) testing was performed before every case at 12/19 hospitals; periodically at 3/19 hospitals; and not at all at 4/19 hospitals. Dosimetric QA/QC techniques included ionization chamber (8/19), film dosimetry (7/19) or an ionization/semiconductor array (7/10); three hospitals used more than two kinds of dosimetric QA/QC techniques.

3.5. Patient Outcome and Side Effects

Since questions about patient outcome and side effects were not mandatory, only six hospitals provided this information. There was a 2-year overall survival of 60% - 90%. Radiation-induced lung injury and chest wall pain were also recorded as most I-II grade.

4. Discussion

SBRT has rapidly become a widely adopted treatment approach in the developed countries. In a recent survey of SBRT use in the United States, 63.9% of evaluable respondents reported using SBRT in their practice [6]. Among SBRT users, lung was the most commonly treated disease site (89.3%). Our survey found that SBRT is commonly offered at the main cancer centers in China as treatment for early staged NSCLC. However, considerable variation exists in the technical delivery of thoracic SBRT with respect to such factors as patient selection, dose/fractionation, and QA/QC strategy.

Although there is a large variation of dose and fractionation identified in our study, our experience appears to be consistent with current practice elsewhere. For example, the National Comprehensive Cancer Network (NCCN) guidelines for thoracic SBRT list a range of suggested fractionation schemes (www.nccn.org). A survey of SBRT in Japan found that the most frequent schedules used for primary lung cancer were 48 Gy in 4 fractions (52%), 50 Gy in 5 fractions (26%) and 60 Gy in 8 fractions (10%) [7]. In the United States, the preferred doses for peripheral T1N0 disease included 54 - 60 Gy in three fractions (56%), 50 - 60 Gy in five fractions (25%) or 48 - 50 Gy in four fractions (18%) [8]. Although the reported Japanese regimen is similar to our own results, a widely used American regimen, 54 - 60 Gy in 3 fractions [4], is not widely used in China. Although the optimal biologically effective dose (BED) for early staged NSCLC arguably warrants further study [9], in general, all of these dose-fractionation regimens are felt to be acceptable in specific clinical situations.

As SBRT depends critically on precise target localization and delivery of a high biologically effective dose with steep dose gradient, set-up and treatment techniques such as IGRT and motion management thereby are very important. The AAPM Task Group 101 report outlines best practice guidelines for the implementation of SBRT and suggests that volumetric image guidance strategies coupled with “integrated image-based monitoring systems or aggressive immobilization” should be mandatory [10]. Our data suggest that not all centers adhere to the AAPM guidelines. In fact, fewer than half of hospitals were equipped with necessary IGRT and QA/QC infrastructure to enable such guidelines to be met.

In this regard, we recommend that binding national

standards be established for those centers that deliver SBRT. Such standards would regulate the training and experience of the radiation oncologists, radiation physicists and technicians, and they would establish consistency regarding QA/QC, treatment simulation, treatment planning, IGRT, dose calibration and follow-up. Such an initiative should improve adherence to relevant published standards and improve the quality of multi-institution trials that are conducted nationally.

In summary, this survey highlights the need for continual evaluation and refinement of the SBRT process, as well as standardization of the treatment planning and delivery process. Our findings recognize that SBRT is widely accepted, though there is considerable variation in its use. We will continue to perform this survey in the future in order that we can recognize and quantify current trends among even more hospitals.

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