Brachytherapy 15 (2016) 361−369

BRACHYTHERAPY

Thoracic

Treatment of recurrent mediastinal lymph node metastasis using CT-guided nontranspulmonary puncture interstitial implantation of ^{125}I seeds: Evaluation of initial effect and operative techniques

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ABSTRACT

PURPOSE: To evaluate the initial effects and operative techniques for treating recurrent mediastinal lymph node metastasis using CT-guided nontranspulmonary puncture interstitial implantation of ^{125}I seeds.

METHODS AND MATERIALS: Thirteen patients (eight men and five women) with a total of 14 recurrent mediastinal lymph node metastatic lesions underwent CT-guided nontranspulmonary puncture interstitial implantation of ^{125}I seeds.

RESULTS: We used the transpleural cavity approach for six cases (air injection of 200−600 mL), the transsternal approach for three cases, the supersternal approach for one case, and the parasternal/paraspinal approach for the remaining cases (including two cases using the salinoma window technique). All patients had good operational tolerance. Mean followup was 16.3 months, with 12 complete response lesions and 2 partial response lesions.

CONCLUSIONS: Treating recurrent mediastinal lymph node metastasis using CT-guided nontranspulmonary puncture interstitial implantation of ^{125}I seeds is safe and effective, with minimal trauma, evident local therapeutic effects, and does not damage lung tissue. However, comprehensive application of multiple puncture assistive technologies, and skill, is required due to the important, anatomically complex structures in the mediastinum.

Keywords: Brachytherapy; X-ray computed tomography; Mediastinum; Lymph node; Iodine 125

Introduction

The mediastinum is a preferred site of metastasis. Tumor progression tends to compress the trachea and blood vessels, causing complications such as superior vena caval obstruction syndrome. Most patients with mediastinal metastases are not suitable for surgery; however, relapse can occur easily following chemotherapy/targeted therapy and external radiation therapy.

Interstitial implantation of radioactive ^{125}I seeds is commonly used for treating solid tumors such as prostate cancer, pancreatic cancer, and lung cancer and achieves good therapeutic effects (1−3). The mediastinal lymph nodes are deeply located, being adjacent to the pericardium, great vessels, esophagus, trachea, and other structures, and puncturing them is difficult, requiring skill. We selected 13 cases with mediastinal lymph node metastasis that received 14 instances of CT-guided ^{125}I seed implantation at our hospital from January 2009 to June 2015 to describe the puncture technique used and to discuss the preliminary therapeutic effects.

Methods and materials

Ethics

Informed consent was obtained from the subjects, and the study was approved by the Ethics Committee of our University.

Patients

All patients (14 lesions) had recurrent mediastinal lymph node metastasis; each had received other treatment before the operation. In all, apart from the site to be implanted,

Received 21 October 2015; received in revised form 6 February 2016; accepted 19 February 2016.

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1538-4721/$ - see front matter
http://dx.doi.org/10.1016/j.brachy.2016.02.007

all other areas of lesion, including the primary tumor and distal metastases, had been effectively controlled. Patients underwent percutaneous CT-guided ^{125}I seed implantation after failure or refusal of conventional treatment (radiotherapy, chemotherapy, or surgery). Patients who refused chemotherapy and radiotherapy were also included. To be included, metastatic lymph nodes had to be less than 7 cm in diameter. Patients were excluded if their primary tumor or metastatic disease was considered uncontrollable, if their expected survival time was less than 3 months, if they suffered from extreme fatigue such that it was considered they would be unable to tolerate the treatment, if they had severe, uncorrectable coagulation dysfunction, or if there was no safe puncture pathway such that damage to the heart or a great vessel was considered a risk. Information concerning patients' ages and sex, the sites of primary and metastatic disease, the treatments received previously, and the recurrence time from last treatment is shown in Table 1. The site of lymph nodes was described using the International Association for the Study of Lung Cancer lymph node map 2009 (4).

Instruments and equipment

We used a Toshiba Aquilion M16 spiral CT scanner, Gallini coaxial biopsy needle (17 G, 11 cm), Hakko percutaneous transhepatic cholangiography drainage (PTCD) needle (18 G, 20 cm), pediatric lumbar puncture needle (22 G, 6 cm), and Gallini bone biopsy needle (11 G, 15 cm).

For treatment, we used a treatment planning system (TPS; HGGR3000, HOKAI, Zhuhai, China) and ^{125}I seeds (HTA, Beijing, China) in a 0.05-mm-thick titanium capsule, with 0.8 mCi/capsule activity and a half-life of 59.6 days.

Preoperative preparation

We performed routine preoperative chest CT scan enhanced examination to determine the relationship between the lesions and the surrounding structures, such as blood vessels. Routine blood testing and clotting times were examined to rule out bleeding disorders.

We performed treatment planning and calculated the seed number and distribution based on the preoperative CT images with 5-mm thick sections. The Monte Carlo algorithm was used for treatment planning. Careful delineation of the gross tumor volume (GTV), the clinical target volume (CTV), and of surrounding vital organs (e.g., heart and spinal cord) were made using each CT slice. CTV was defined as a 1.5 cm of expansion external to the GTV. Based on the three perpendicular diameters within the target tumor, a matched peripheral dose averaging 110 Gy (100–130 Gy) was prescribed. The equivalent dose in 2 Gy fractions (EQD2) was 78.62 Gy (α/β 10 Gy for tumor). TPS was used to generate a dose-volume histogram, isodose curves of different percentages, and to determine the position of the brachytherapy applicator and the dose and number of implanted seeds. CTV edge was covered by isodose curve from 70–90%.

Operation method

General procedure

All procedures were performed by interventional radiologists. After patients had been laid on examination beds in the appropriate position, homemade grids were pasted on them as surface markers. CT location scan was conducted first; for some patients, using the nonaxial needle angle required multiplanar reformatting based on the preoperative scans to determine the puncture path to avoid large blood vessels and other important structures (Fig. 1). Routine disinfection, draping, and local anesthesia were carried out, and the 17-G coaxial needle was gradually inserted under CT guidance. The coaxial needle has a flat head design, and the needle core can be removed if necessary. Blunt tissue dissection was used to avoid damaging the blood vessels and trachea (Fig. 2). After reaching the edge of the lesion, the needle core was removed and the 18-G PTCD needle was inserted distally into the lesion, and then, the ^{125}I seeds were implanted. The needle was withdrawn gradually, and the angle of insertion was adjusted, completing the treatment according to the TPS plans. The needle was withdrawn after the operation, and then, routine chest CT scan was conducted to confirm the presence or absence of hemorrhage, pneumothorax, and other complications. A standing chest radiograph was obtained 24 hours after the operation.

Parasternal/paraspinal or supersternal approach

When there was no other structure between the chest wall and the mediastinal lesion, the parasternal (anterior mediastinum)/paraspinal (posterior mediastinum) or supersternal approach could be used (needle is punctured through the skin to the chest wall to the lesions). When the parasternal/paraspinal puncture path was narrow, we used the salinoma window technique. The external pulmonary puncture path was artificially expanded by injecting 20–30 mL saline between the parietal pleura and the sternum/spine before needle insertion, creating an artificial salinoma (Fig. 3).

Transsternal approach

When there was no other structure between the sternum and lesions, we used the transsternal approach (needle is punctured through the skin to the sternum to the lesion) (Fig. 4). A small hole was made at the skin entry point to drill the sternum along the proposed puncture angle using the 11-G bone biopsy needle. Bone substance was removed after the sternum had been penetrated, the bone biopsy needle was withdrawn, and then, the coaxial needle was inserted into the lesion through the hole.