ADVANCES IN RADIOSURGERY

LETTER FROM THE DIRECTOR

In past issues of "Advances in Radiosurgery," we discussed general concepts of radiosurgery and technical advances aimed at more targeted treatment. We also showed how to apply radiosurgery to the brain and spine tumors. Over the past 10 years we have seen a significant surge in the use of stereotactic radiation for extracranial sites. When this technique is applied to extracranial sites, it is called stereotactic body radiotherapy (SBRT). The most common and first site of SBRT application was for lung cancers, one of the most common types of cancers. Many lung cancer patients are not suitable candidates for surgical resection because of poor lung function due to various reasons. SBRT is a non-invasive procedure, and it can focus the sharply manipulated beams to the lung cancer only. It minimizes toxicity by limiting the radiation beam to the normal lung tissue. Therefore, it can be an ideal treatment option for selected cases of early-stage inoperable lung cancers.

Lung radiosurgery/SBRT is unique because of breathing-related tissue movement. Therefore, special techniques to manage tissue movement are needed. Many of the early experiments of breathing-related lung cancer motion, such as respiratory gating and tumor tracking, have been performed by our radiosurgery team. To date, Henry Ford's Department of Radiation Oncology has performed more than 250 lung SBRT procedures. I invited Munther Ajlouni, M.D., our lung SBRT team leader, to write about the clinical application of SBRT for treatment of early-stage lung cancer and summarize our experience.

It is very rewarding to see how our vision and research has translated into a clinical program that greatly benefits cancer patients.

Samuel Ryu, M.D.
Director of Radiosurgery
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RADIOSURGERY/STEREOTACTIC BODY RADIATION THERAPY FOR EARLY-STAGE LUNG CANCERS

Treatment options of early-stage (stage IA and IB) non-small cell lung cancers include surgical resection when possible. In the past, patients who were not eligible for surgery were treated with standard fractionation radiation therapy that required six to seven weeks of daily treatments which included a significant amount of uninvolved lung. The long-term control rates ranged from 15 percent to 40 percent depending on the stage, tumor size and radiation dose. It was clear that a better alternative to the non-surgical treatment of these tumors was necessary. Recent progress in radiation delivery systems has allowed us to treat these early lung cancers with stereotactic body radiotherapy (SBRT) techniques. We have treated these patients with 48 Gy given in four sessions of SBRT. Other dose schedules used range from 45 Gy to 60 Gy in three to five fractions. The results have been very promising with improvement of tumor control rates to 85 - 95 percent.

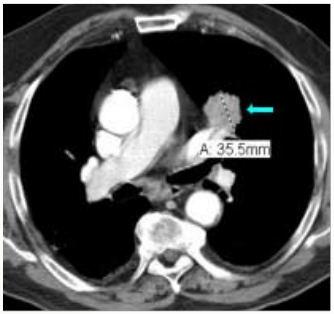
Munther Ajlouni, M.D.

Technically, lung tissue and the tumor move with respiration, which makes the use of a highly conformal radiosurgical dose very challenging. In order to treat lung cancers with SBRT, the following techniques have been developed:

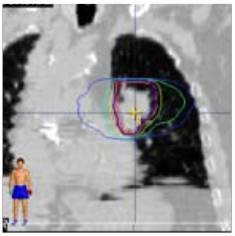
- Gated CT scans for treatment planning that takes into account the three-dimensional movement of the target in relation to the breathing cycle, hence called 4-D scans. This allows us to create a treatment volume that takes into account the full motion of the tumor during respiration. With this technique, we are able to minimize the amount of normal lung treated.
- The use of stereotactic techniques to better target the tumor volume.
- Better methods to immobilize (position) the patient during the SBRT procedure.
- Image guided radiation therapy (IGRT). Immediately before the actual treatment, pretreatment imaging is obtained that helps confirm the accuracy of the treatment and, if necessary, adjust for any variations.

RADIOSURGERY

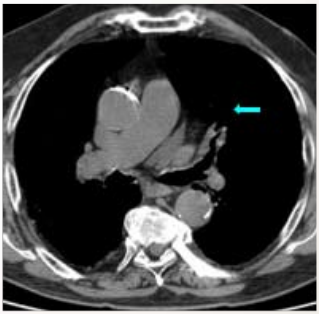
The Henry Ford Department of Radiation Oncology has treated more than 250 lung cancer patients utilizing SBRT. The majority of these have been inoperable stage I non-small lung cancers. The remainder included various metastatic tumors (colon, renal, melanoma and sarcoma) to the lung. Tumors treated thus far have included both peripheral as well as central lesions. We currently use 4-D treatment planning and several types of treatment systems that are capable of image-guided positioning and targeting, beam intensity modulation and dose shaping, and verification of the treatment delivery. The results of SBRT have been extremely promising so far. The first 50 patients treated were evaluated for control rate and complications. At a median follow-up of 30 months, the local tumor control rate is 95 percent and the survival rate is 68 percent. These results are similar to those achieved with surgery. The complication rate has been minimal with no significant long-term complications. One example of tumor response is shown in the figures below.



Before Treatment



SBRT 12 Gy x 4 sessions



After Treatment

The use of SBRT for inoperable, early-stage lung cancer has become the standard of care at Henry Ford. This is certainly the trend in many other institutions. There are ongoing phase II and III trials that will further clarify the indications for radiosurgery/SBRT as well as optimal radiation dose and fractionation. One phase III trial that recently opened in Europe is comparing the use of SBRT to surgery in operable stage I non-small cell lung cancer. Presently, the Henry Ford team is utilizing SBRT for all inoperable early-stage lung cancers, as well as for limited lung metastases.

We discuss each patient case in the weekly multidisciplinary lung tumor board meeting and radiosurgery conference to coordinate the treatment customized to the patient's individual needs.