Journal of Radiotherapy in Practice

Journal of Radiotherapy in Practice (2007)
6, 59–61

doi: 10.1017/S1460396907005067

Guest Editorial

Versatility is the key for the future of radiotherapy linear accelerators

Neil Madle

Corporate Communications & Investor Relations Director, Varian Medical Systems, Europe

Speciality machines have been the norm for stereotactic cancer treatments in recent years. Yet, speciality machines have many drawbacks, including the high cost per treatment, slow delivery, patient discomfort and the limited number of treatments that can be carried out per day. Despite these limitations, stereotactic treatments – particularly intracranial – have tended to be performed using dedicated neurosurgical tools such as the GammaKnife. Radiation oncologists have had little option but to refer such patients to neurosurgeons rather than continuing treatments themselves.

With the introduction of the Trilogy linear accelerator, Varian Medical Systems is pioneering the 'all-in-one' approach to radiation therapy: a single machine that can handle all forms of radiotherapy treatment – conformal, intensity modulated, image guided and stereotactic – as effectively as dedicated equipment but with the added benefits of speed, accuracy and versatility.

A single Trilogy treatment session can be as brief as 10 minutes, which is significantly faster than most other radiosurgery systems. Shorter treatment times, higher dose delivery rate and automated beam shaping that covers the full field in a single shot reduce the effects of motion and enhance patient comfort. In addition, recent studies suggest that faster treatments can be more biologically effective.

As for accuracy, 3D computed tomography (CT) imaging in the treatment room ensures the target is accurately positioned immediately before treatment. Using an optical-guidance system that is virtually identical to existing systems in the operating room, Trilogy monitors and corrects for patient movement in real time. Used in combination with respiratory gating, Trilogy can further enhance accuracy by synchronizing beam-on with the natural breathing pattern of the patient.

In addition, Trilogy takes stereotactic treatments beyond the patient's head and shoulders, enabling whole-body stereotactic treatments to become a routine and straightforward way of controlling metastases. The machine's advanced technology enables both radiation oncologists and neurosurgeons to treat a wide range of abnormalities from small functional lesions to larger lesions in cranium and spine, many of which would previously have been considered inoperable. With the Trilogy medical linear accelerator, multiple lesions can be treated at the same time, all on an outpatient basis and with fewer side effects.

FRAMELESS RADIOSURGERY

Radiation oncologists at Emory University in Atlanta recently launched a programme to treat brain tumours with frameless radiosurgery using the Trilogy device and other image-guidance tools from Varian. This state-of-the-art treatment enables physicians to position and monitor patients accurately during radiation treatment using both optical guidance cameras and cone-beam CT, which obviates the need for a standard rigid head-frame.

Correspondence to: Neil Madle, Corporate Communications & Investor Relations Director, Varian Medical Systems, Europe. E-mail: neil.madle@varian.com

Ian R. Crocker, professor of Radiation Oncology at Emory University School of Medicine, and his staff recently treated a 60-year-old woman who presented with two brain metastases after treatment for non-small-cell lung cancer. In March 2006, after successful chemotherapy and surgery for the lung primary, the woman noticed a slight drooping of the left side of her face. A magnetic resonance imaging (MRI) scan revealed an 11-mm right frontal mass consistent with a metastasis. She underwent conventional stereotactic radiosurgery for this lesion on 25 May.

The patient described the stereotactic headframe experience as excruciating and something she would never do again, according to Dr. Crocker. During her first follow-up visit in July, there was a decrease in the treated lesion, but there was a new metastasis in the right cerebellum. It was decided to treat her with frameless radiosurgery, the first ever at Emory. According to Dr. Crocker, the patient was thrilled with the new procedure.

On the day of treatment, the Emory team used Varian's FramelessArray optical guidance system to position the patient for treatment. This device uses an optical camera to analyze the patient's position by continuously monitoring a set of reflective markers attached to the bite plate. This technology also monitors the patient for any movement during treatment. If a patient does move, the treatment stops until the patient can be placed back into the correct position.

After the patient was positioned for treatment, a cone-beam CT scan was acquired using the On-Board Imager kV imaging device mounted on the Trilogy accelerator, and this image was compared with the earlier CT scan that had been used to plan the treatment.

It took the Emory team less than an hour to position the patient and complete her treatment. Emory's doctors are in the process of implementing dynamic conformal arc techniques, which will bring down treatment times even more. At the patient's first follow-up visit in September, her tumours were shrinking and she had no new tumours.

STEREOTACTIC BODY RADIOSURGERY

Meanwhile, clinicians at the Melbourne Internal Medicine Associates (MIMA) Cancer Center in Melbourne, Florida, have begun treating early-stage lung cancer with stereotactic body radiosurgery using their Trilogy medical linear accelerator, configured with the On-Board Imager device for image-guided radiotherapy and the real-time position management (RPM) respiratory gating system for managing tumour motion. The treatment protocol, which involves delivering a full therapeutic dose to a lung tumour over three to five consecutive treatment sessions, is offered to select lung cancer patients who are not candidates for conventional surgery and who, for one reason or another, cannot complete the standard six-to-seven-week course of radiotherapy.

Using this technique, the dose is delivered in three to five sessions using an average of seven to nine fields, and these are usually coplanar to minimize the treatment time. Doctors at MIMA deliver a 'sliding window' (continuous-beam) intensity modulated radiation therapy (IMRT) treatment, usually in under 15 minutes, bringing the total duration for treatment to about 30 minutes per session.

To position the patient for treatment, the MIMA team generates a new cone-beam CT volumetric image using the On-Board Imager and the deep inspiration breath-hold method, and compares the image with the corresponding images from the treatment plan. The On-Board Imager then calculates the amount of couch shift needed in each of three dimensions to fine-tune the patient's position.

The treatments are delivered using the RPM respiratory gating system so that the dose is delivered during the appropriate phase of the respiratory cycle, when the tumour is in the optimal position for treatment.

Since the 1950s, doctors have treated certain brain tumours in this way – giving high, focused doses to very small targets using stereotactic radiosurgery. But when treating below

https://doi.org/10.1017/S1460396907005067 Published online by Cambridge University Press

the neck, they have been limited in using this technique beyond the cranium because of localization challenges as a result of the organ motion that occurs when the patient breathes. As the lungs expand and move during the breathing cycle, the tumour moves with them, a problem that does not exist when lesions in the brain are treated. New imaging and gating technologies now enable clinicians to localize and effectively 'freeze' the organ motion so that a high, focused dose to a small lung tumour can be delivered while limiting the amount of normal lung irradiated. This, in turn, has the potential to minimize side effects.

Between March and August 2006, the MIMA team treated four early-stage lung cancer patients with this type of hypo-fractionated radiosurgery protocol. According to radiation oncologist, Dr. Nanialei Golden, toxicity has been almost nil, they have noticed only mild fatigue and there has been no decline in breathing function and no other respiratory complications.

NEW HOPE FOR PATIENTS WITH METASTATIC CANCER

Clinicians at the Virginia Commonwealth University Massey Cancer Center were among the first in the world to use the new image-guided radiosurgery (IGRS) technology offered by Trilogy to control the spread of metastatic cancer.

Theodore Chung, a radiation oncologist and associate professor at the Virginia Commonwealth University School of Medicine, used the new technique to offer new hope to a 47-year-old mother of four whose breast cancer was spreading to her brain and liver. The patient had first been treated for breast cancer five years earlier, and it seemed to be under control until metastatic lesions began to appear. Chung treated several of her metastatic lesions with IGRS, an ultra-precise procedure that makes it possible to monitor, track and target tumours with high doses of radiation in just one to five treatment sessions.

According to Dr. Chung, the real-time imaging and targeting capabilities of the Trilogy system are helping to turn cancer into a controllable disease, something he describes as a 'new era in cancer treatment' where radiation oncologists can actually begin to control metastatic spread.

SUMMARY

With versatile accelerators such as the Trilogy device, radiation oncologists can now collaborate with neurosurgeons to treat complex brain lesions without performing invasive conventional surgery. In addition, Trilogy is not limited to intracranial stereotactic treatments. It can carry out ultra-precise stereotactic radiosurgery (one session) or stereotactic radiotherapy (two to five sessions) anywhere in the body, opening up new tumour treatment opportunities for clinicians and more effective treatments for patients. Increasingly, neurosurgeons are also recognizing the limitations of dedicated intracranial stereotactic tools and embracing the opportunities offered by more versatile whole-body machines to broaden their treatment offering.

Since its launch, the Trilogy system has been installed – or is being installed – in more than 80 hospitals around the world, including leading oncology centres in the United States, Europe, Malaysia, Taiwan and Australia. It is proving to be an important and valuable addition to the neurosurgery toolbox, an extension of the radiation oncologist's capabilities and a tool of hope for cancer patients around the world.

https://doi.org/10.1017/S1460396907005067 Published online by Cambridge University Press