Clinical Efficacy of Telemedicine in Emergency Radiotherapy for Malignant Spinal Cord Compression

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The authors developed a Telecommunication-Helped Radiotherapy Planning and Information System (THERAPIST), then estimated its clinical benefit in radiotherapy in district hospitals where consultation with the university hospital was required. The system consists of a personal computer with an image scanner and a digital camera, set up in district hospitals and directly connected via ISDN to an image server, and a treatment planning device set up in a university hospital. Image data and consultative reports are sent to the server. Radiation oncologists at the university hospital determine a treatment schedule and verify actual treatment fields. From 1996 to 1999, 12 patients with malignant spinal cord compression (MSCC) were treated by emergency radiotherapy with the help of this system. Image quality, transmission time, and cost benefit also were satisfactory for clinical use. The mean time between the onset of symptoms and the start of radiotherapy was reduced significantly from 7.1 days to 0.8 days ($P < .05$) by the introduction of the system. Five of 6 nonambulant patients became ambulant after the introduction of THERAPIST compared with 2 of 8 before the introduction of THERAPIST. The treatment outcome was significantly better after the introduction of the system ($P < .05$), and suggested to be beyond the international standard. The telecommunication-helped radiotherapy and information system was useful in emergency radiotherapy in district hospitals for patients with MSCC for whom consultation with experienced radiation oncologists at a university hospital was required.

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TREATMENT PLANNING of radiotherapy is a complicated process in which well-rounded knowledge in clinical oncology, anatomy, tumor spread, and each patient's condition is required of physicians. It is ideal for cancer patients to be seen by cancer specialists who fulfill requirement. However, there can be a situation in which patients do not have direct access to such specialists because of various difficult situations, such as living in isolated communities, developing countries, under heavy weather, or in an emergency at midnight. In such circumstances, radiotherapy can be performed by a radiation oncologist who is qualified in terms of knowledge but has less experience. Some hospitals may not have a medical physicist for quality assurance. Even in advanced countries, proper treatments for rare diseases often require guidance from specialists in university hospitals. Teleradiology is expected to be useful in such circumstances because it has been proven so in diagnostic radiology. To assist radiotherapy in the difficult circumstances, we have developed a telecommunication-helped radiotherapy planning and information system (THERAPIST), and have been evaluating the efficacy of system since 1997.

Malignant spinal cord compression (MSCC) is known to be an oncologic emergency. The treatment outcome of patients with MSCC depends on the time between the onset of symptoms and the start of radiotherapy. If radiotherapy is not performed within 24 to 48 hours after the onset of MSCC, most patients cannot recover from paralysis. A portion of the patients may require surgical decompression. However, even in hospitals in which radiotherapy equipment is available, experienced neurologists, neuroradiologists, radiation oncologists, and surgeons may not all be on staff. In such cases, patients may not be able to receive emergency radiotherapy within the appropriate time period.

Telecommunications may be helpful to improve this situation. Here, we report our prospective trial using THERAPIST in the treatment of MSCC in a district hospital.

MATERIALS AND METHODS

The THERAPIST consists of computer terminals with an image scanner, 2 image monitors, and a digital camera set up in district hospitals and directly connected via ISDN-64 to an image server with 2 image monitors, and a treatment planning system set up in the university hospital (Fig 1) Windows NT4.0 (Microsoft Co.) is used as the operation system. Various types of computed tomography (CT), magnetic resonance imaging
(MRI), x-ray devices, and Gamma cameras were used for diagnostic purposes with remote consultation using THERAPIST in each peripheral hospital. However, all images were digitized by the same scanner (ES-8000, EPSON Co, Tokyo, Japan) in this study. For emergent radiotherapy, we used a treatment simulation CT (Xviger with CT port; Toshiba, Tokyo, Japan) and \textsuperscript{60}Co-treatment device (RCR-120; Toshiba) in the peripheral hospital. Each image is digitized by a 250-dpi image scanner and compressed by JPEG (Joint Photographic Experts Group) 10:1 compression, lossy, and sent to the server. Data of CT can be transferred for dose calculation. Each CT or MRI file contains 12 images, which were digitized by image scanner. As of October 2000, 6 district hospitals were connected to the server in the university hospital.

Patients with MSCC are treated according to the following procedure. (1) Informed consent about consultation: A radiation oncologist or referring physician in the district hospital examines the patient. After obtaining the informed consent of the patient, the attending oncologist or physician consults with the university hospital to discuss suitable treatment. CT, MRI (0.5T), bone x-ray, bone scintigram, a consultative report, and digital photographs of the patient under physical examinations are sent to the server. When a doctor in a remote hospital needs to consult with the radiation oncologists in the university hospital, they call the radiation oncologists using a telephone or beeper and begin the session of telecommunication. E-mail communication was used for nonemergency cases. (2) Treatment planning: The referral doctor explains the results of the consultation to the patient and obtains the patient's informed consent to perform the treatment. CT treatment simulation is performed via telecommunication. The radiation oncology team in the university hospital performs treatment planning using the CT images that have been sent from the district hospital. Dose distribution is calculated using the 3-dimensional dose calculation system in the university hospital. (3) Treatment verification: A portal image is taken at the district hospital using megavoltage treatment x-ray and sent via telecommunication to the university hospital for treatment verification. A treatment simulation image, or a digitally reconstructed radiograph (DRR) from treatment simulation CT images also is sent for comparison. (4) Actual treatment in the district hospital: After the acceptance of verification film by the radiation oncologist in the university hospital, the patient receives emergency radiotherapy in the district hospital. Radiotherapy is scheduled to