Editorial

Surgical organ displacement: what is the best "materials and methods" for proton radiotherapy?

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In the mid 1940s, Robert Wilson (1) hypothesized that a highly localized deposition of energy from a proton beam could be used to increase the radiation dose to tumors while minimizing radiation to adjacent normal tissues. The depth-dose distribution of a proton beam differs significantly from that of a photon beam. Protons show increasing energy deposition with penetration distance, reaching a maximum-named the Bragg peak-near the end of the range of the proton beam. In front of the Bragg peak, the dose level is modest compared to photon beams; beyond the Bragg peak, the dose decreases to nearly zero. By choosing the appropriate proton beam energy, the depth of the Bragg peak can be adjusted to match the depth and extent of the target volume. Therefore, excellent conformality can be achieved, in contrast to conventional or intensity-modulated radiotherapy (IMRT).

Protons have a higher linear energy transfer (LET) than photons, but their radiobiological properties do not differ substantially. In clinical applications, the absorbed dose is multiplied by a factor of 1.1 to convert the relative biological effectiveness (RBE) of a proton beam to cobalt gray equivalents (CGE) or gray equivalents (GyE) (2). In 1954, scientists at the Lawrence Berkeley Laboratory initiated the first studies of proton radiotherapy (PRT) to support Wilson's hypothesis. Therefore, PBT has been studied for over a half a century, and more than 83,000 patients worldwide are reported to have been treated with proton beams (3-7).

The most significant change to PRT occurred in the 1990s, when the Loma Linda University Medical Center began to use PRT clinically, and became the first hospital based medically dedicated proton therapy facility in the world (8). Since then, similar medically dedicated facilities have been constructed around the world. At present, almost 50 particle therapy facilities are operating worldwide, and it is estimated that the number of facilities will increase to 70-80 within 5-10 years. Despite these physical advantages, proximal and lateral dose is still the modest, and it never reaches to be zero. Therefore, if organs or structures that are sensitive to radiation located closely adjacent or abutting vulnerable, especially digestive tract, it is difficult to irradiate sufficient dose to the tumor.

The article by Jesseph and colleagues in *Translational Cancer Research* described their single-institution experience of the use of surgical organ displacement in the treatment of abdominal, pelvic, or retroperitoneal tumors by PRT (9). The aim of this intervention is to make a space between tumor and digestive tract in order to perform PRT with a curative intent. Their findings are noteworthy. All of the 15 patients who did surgical organ displacement obtained adequate displacement to allow successful proton treatment planning. Furthermore, there were no surgical complications. These methods described by Jesseph *et al.* might not only allow us to irradiate sufficient dose to the tumor, but also expand indication of PRT.

Materials

The ideal materials are not yet found. Patients' own tissue, such as omentum, is considered to be safe and effective, because it does not cause rejection reaction. Omentum is sometimes used in the treatment of liver or pancreatic cancer in Japan also.

How about artificial materials? Breast prosthesis and tissue expander Jesseph *et al.* used are originally developed for other purposes. The safety of these materials is already confirmed. In Japan, Gore-tex sheet is commonly used (10,11), and use of breast prosthesis or tissue expander is rare. One of the problems is that some patients complain discomfort or pain by inserting artificial materials.

So, what is the ideal material? I would like to suggest that the density of the material should be water equivalent, because this enables us to calculate accurate dose distributions. The material remains as a spacer for a couple of months (at least treatment duration), then melt and disappear thereafter. Development of such a material is highly warranted.

Methods

Surgeons familiar with this surgical intervention might be quite few. Collaboration with radiation oncologists is essential at present. More education and understanding of surgical organ displacement to surgeons is needed.

Patients' own tissue might be leaved on, but artificial materials should sometimes be removed depend on patient's complaint. However, this intervention is not so easy, and it is not necessarily to be preferred because it involves invasive. The best methods require further investigation.

Finally, reimbursement of this procedure might be different by each country. In Japan, all of the cost (including the cost of insertion materials) and fee are not covered by social insurance at all. Therefore, patients have to pay all of them by themselves.

Despite these problems, surgical organ displacement and spacer insertion are quite effective methods in the field of PRT. There is still room for improvement, further research and development are needed.

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