EDITORIAL

Image Correlation: Applications in Nuclear Medicine and Beyond

In this issue, Yu et al. (*1*) evaluate the ability to register the emission and transmission scans of patients undergoing thoracic PET studies. They utilize a surface-fitting image correlation technique developed by Pelizzari et al. (*2*) and conclude from phantom and patient studies that internal structures (lungs) can be registered to approximately 3 mm and 2 degrees. The ability to repeatedly register PET studies obtained at different times is important in the attenuation corrections applied to these scans to extract quantitative data.

Image correlation has many potential applications in nuclear medicine. Indeed it is very natural to want to combine the high-resolution anatomical delineation of structures as visualized on MRI or CT with the less spatially resolved but functional biochemical images from PET and SPECT. Both modalities benefit from this correlation. Examples of successful clinical applications of correlating nuclear medicine studies with high-definition anatomical studies include correlation of structure and function studies such as registration of PET and MRI (*3*), three-dimensional displays for surgical planning (*4*), registration of SPECT and MRI (*5*) and the use of SPECT/CT/MRI registration for localization of tumors by radioimmunoconjugates (*6*).

The most important consideration of an image registration technique is its accuracy in its clinical utilization. Many algorithms can register two three-dimensional data sets to a mean value whose magnitude is less than the RMS value of the sum of the squares of the pixel sizes (*2,7,8*). For PET and CT, this value is approximately 3–4 mm. A second consideration is the ability to retrospectively register image data sets, independent of patient positioning or imaging plane. Thus, an axial SPECT can be registered with a coronal MRI study. Currently, surface fitting is the most common method of objectively registering nuclear medicine studies with CT or MRI. Recently, Hill et al. (*9*) published a point-to-point method for registering high-resolution studies, where homologous points can be accurately defined.

The ability to repeatedly reproduce patient position is important in other areas of medicine also. In radiation therapy practice, a patient is typically repositioned and treated in 30 fractions over 6 wk. As conformal high-precision radiation therapy (*10*) comes of age, the ability to reposition becomes more critical. In stereotactic radiosurgery/radiotherapy (*7*) the lesion is repositioned on the treatment machine to within 1 mm of its position as localized on CT (through the use of specialized hardware). In the thorax, skin marks and alignment lasers are routinely used for treatment setup, and the patient is generally aligned with confidence to 5 mm. This accuracy is more difficult to achieve when the skin is loose, or when a significant amount of adipose tissue is present.

Accuracy here generally refers to the registration of bony structures relative to a coordinate system. Conventional diagnostic films, or films taken with the therapeutic photon beam prior to patient treatment, provide the data to substantiate these claims. Precise alignment to bony landmarks does not necessarily align the volume of interest (tumor) to the treatment machine, given soft-tissue organ motions.

What can we look forward to in the near future? Technical improvements in image correlation algorithms and additional clinical applications (*10,11*) as more techniques become available. In addition, the power of computer graphics and volume-rendering advances will provide all interested physicians with realistic images of structure and function derived from multiple imaging modalities.

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