WHITE PAPER

MIM® for Therapy Response Evaluation

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Overview

Quantitative methods of tumor response have traditionally been global in nature and primarily began with monitoring changes in tumor maximal diameter. Over time, methods have progressed to involve monitoring changes in volume and now also include FDG-PET measures of response such as SUVmax and Total Glycolytic Activity (SUVmean x volume). These measures have become more prevalent with the increasing use of PET/CT for monitoring response. FDG-PET has begun to play an important role in the earlier detection of response with changes in the metabolic activity of tumors often being seen earlier than anatomical changes.

MIM provides a comprehensive, multi-modality solution to quickly and accurately generate quantitative statistics for therapy response. Tools are provided to aid the clinician from initial diagnosis to follow up with multiple comparison exams over time to monitor response to therapy.

Tumor Segmentation

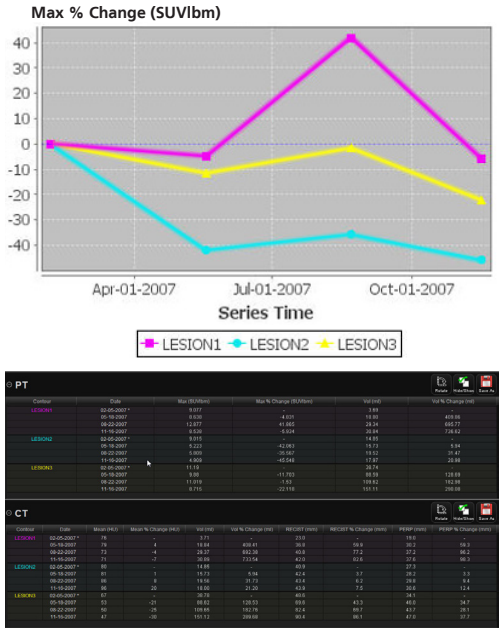
When using tumor statistics to evaluate response such as volume and Total Glycolytic Activity, accurate tumor segmentation is essential. PET Edge®, an automatic PET segmentation tool, is based on image intensity gradients and has been shown to provide more accurate and consistent results[1-4] with less inter-observer variability[3] than constant threshold PET segmentation methods and manual contouring.

PET Edge uses the actual image data and is not affected by display contrast, which is one of the limitations of manual visual contouring techniques. PET Edge is able to account for heterogeneous activity in tumors, which is not possible with constant threshold techniques, and is less sensitive to changes in source-to-background ratio and partial volume effects.[1]

In data presented at the SNM 2009 Annual Meeting, D Nelson et al. demonstrated that the more accurate segmentations from PET Edge resulted in statistically more accurate Total Glycolytic Activity measures. This result has the potential to be important with the increasing evidence that Total Glycolytic Activity can play an important role in prognosis[5,6] and therapy response.[7,8]

Segmented tumors can be saved as RTstructs for comparison to later exams, saved to PACS, or sent to treatment planning systems for use in Radiation Therapy. Accurate segmentations of the PET data is essential when this information is being used in creating target volumes for radiation treatment.

Figure 1



MIM automatically registers any number of exams using the accuracy of a CT-CT registration, allowing easy comparison of any number of time points. Tumor contours from the previous time points can be loaded and the new PET/CT can be quickly contoured with PET Edge, providing quantitative results, time activity graphs, and visual confirmation of changes over time *(see Figure 1)*. Contours can also be rigidly or deformably copied from the previous exam to the current exam, allowing tumor statistics to be calculated even when there is negligible FDG tumor uptake on the current exam.

Visualize Changes

Changes between exams are highlighted through the creation of difference images. Difference images are created by subtracting the previous PET from the current PET, providing a method to highlight changes that is not affected by display contrast which can influence visual reads *(see Figure 2)*. The difference images are provided in quantitative color scales aligned to either the previous or current CT image volume for better anatomical localization of the changes between exams.

Rigid registration of FDG volumes is sufficient for creating difference images when tumor size in CT volumes has not changed significantly. The difference images can be expressed as a subtraction of the previous and current image volumes or as a percent change on a voxel-by-voxel basis. The image volumes can be normalized based on the activity in an operator-selected region such as the cerebellum, liver, or mediastinal blood pool to account for variables that affect SUV measures between studies.

Figure 2

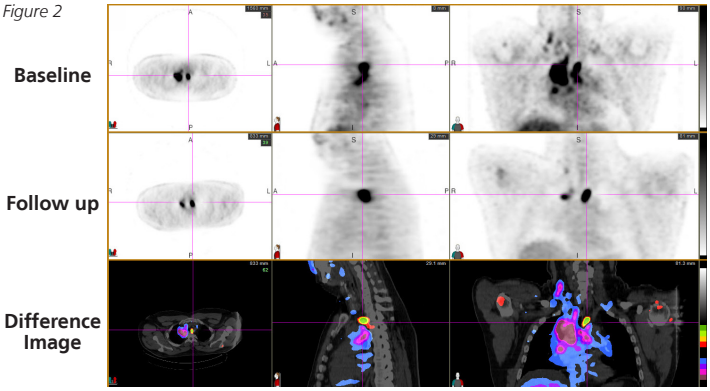


Figure 2 highlights a para-aortic lymph node that had increased FDG activity following therapy for a lymphoma patient. Yellow/Green is decreased SUV and Purple/Blue is increased SUV from the earlier to the later time point.

Figure 3

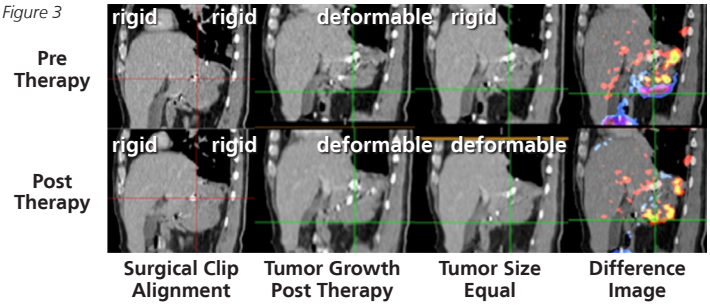


Figure 3 demonstrates that deformable registration is necessary to evaluate regional response when a tumor changes size. RECIST criteria indicate tumor growth in this patient. Rigid registration indicates both increased SUV at the tumor edge and decreased SUV in the tumor, whereas deformable registration indicates only decreased SUV in the tumor.

References

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